Cranfield University

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Better Safe than Sorry:
Towards Appropriate Water Safety Plans for Urban Self Supply Systems

School of Applied Sciences

PhD Thesis

Academic Year: 2006 – 2009

Supervisors: Prof. Richard C. Carter and Dr. Jennifer Smith

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ABSTRACT

Self Supply Systems (SSS) can be defined as privately owned household level water sources. The research focus is on urban self supply hand dug wells in Abeokuta, Nigeria. Self supply wells serve an estimated 45% of Abeokuta's population. SSS can be gradually upgraded to improve water quality, but water quality can also be improved through effective risk management. The World Health Organization (WHO) has developed a risk management tool known as Water Safety Plans (WSP), but the tool has not been tried for SSS. This research focuses on the relevance of the generic WHO water safety plans tool to SSS, with the aim to develop an appropriate water safety framework for self supply sources to ensure acceptable household water.

Water from self supply wells is used for both ingestion and non-ingestion household activities. The water quality of the sources is poor and not safe for consumption with faecal coliform counts in excess of 100 cfu/100 ml of water. Self supply wells in Abeokuta are plagued by four main water safety threats; style of source operation – primarily through bucket and rope -, construction problems, proximity to sources of contamination, and user's hygiene practices. Users are in denial of the health consequences of unsafe water. There is a predominantly reactive attitude to water safety management. The main source management approaches include access and hygiene management. To appropriate existing WSP to SSS, source and water safety control measures require user acceptability to be sustainable in terms of adoption and compliance. Incentives are needed for the adoption of SSS water safety plans. A two-phase supporting program is necessary: awareness and enlightenment campaigns and relevant training activities. Water safety development for self supply wells need to be initiated and coordinated by an established institution other than the source owners. This research suggests the Department of Public Health as the institution to facilitate the development of water safety plans for SSS in Abeokuta, Nigeria.

Keywords: Nigeria, groundwater, water quality, sanitary survey, risk management, hand dug wells, Abeokuta

DEDICATION

To my three sweeties:

Hallel,

Praise, &

Delight

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Finally, 'I can't but sing of my Redeemer's praise…the lifter-up of my head, the giver of life and grace'. His grace indeed is sufficient for me, thank you Lord.

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LIST OF ABBREVIATIONS AND ORGANISATIONS

DALY	Disability Adjusted Life Year
EC	Electrical conductivity
FC	Faecal coliforms
FEPA	Federal Environmental Protection Agency
GRA	Government Residential Areas
HACCP	Hazard Analysis and Critical Control Points
LLA	Land lord associations
MDG	Millennium Development Goals
NAFDAC	National Agency for Food and Drugs Administration and Control
NRU	Non-resident user
OGRUWATSAN	Ogun State Rural Water and Sanitation Agency
PHD	Public Health Department
QRA	Qualitative risk assessment
RBDA	River Basin Development Authority
RU	Resident user
SI	Sanitary inspections
SO	Source owner
SON	Standards Organisation of Nigeria
SSS	Self supply systems
SSWSP	Self supply water safety plans
TC	Total coliforms
WHO	World Health Organisation
WSP	Water Safety Plans

PART I: SETTING THE SCENE, LITERATURE REVIEW, THE RESEARCH AREA AND RESEARCH METHODS

Picture taken: 19/07/2007; NB: The well typifies the most common method (bucket and rope) of water abstraction, children well operators, and unhygienic well handling (e.g. well cover placed on the floor)

A self supply hand dug well, Abeokuta, Nigeria

1 SETTING THE SCENE

1.1 Introduction

The target[1] for water supply in the Millennium Development Goals, (MDG) is to halve, by 2015[2], the proportion of the population without sustainable access to safe drinking water. Progress towards achieving the MDG has been slow especially in Sub-Saharan Africa. In Sub-Saharan Africa approximately 140 million people still obtain drinking water from unprotected wells and springs and approximately 134 million from polluted surface water sources (RWSN, 2004; JMP, 2006a).

To meet the MDG target by conventional means would require current investment in provision of potable water to double or even higher. Such increases in investment are unlikely because bilateral aid to the sector has progressively decreased since 1993 (RWSN, 2004). Community water supply is featuring as a low priority in many countries' poverty eradication strategies (RWSN, 2004).

The need to meet the MDG targets necessitates the adoption of other strategies in water provision. One of the explored strategies is the concept of self supply. Self supply refers to local-level or private initiatives by individuals or households to improve their own water supplies, without waiting for help from Government or Non-government Organizations (Carter, 2006). Self supply systems include scoop holes, springs, unlined wells and rainwater collection.

The concept of self supply offers improved water quality, however, the concern for water quality relative to access and affordability is low. Self supply systems are also generally unregulated.

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[1] The target for water supply is the third under Goal 7 of the eight MDG. Goal 7 is environmental sustainability.

[2] 2015 is relative to 1990. The MDG declaration was made in 1990.

The World Health Organization (WHO) introduced ‘Water Safety Plans’ in the third edition of the Guidelines for Drinking-Water Quality (WHO, 2004a). The water safety plans framework was developed to achieve better health protection (through improved drinking and household water quality), serve as a regulatory tool, and a policy framework.

Water safety plans can be described as an effective means of risk management through a systematic approach, in which risks from catchments to consumers are identified and mitigated. The plans comprise system assessment, operational monitoring, and management plans.

Water safety plans are largely designed for utility operated water supplies with distinct catchment, treatment and distribution networks and to a lower extent, community water supplies. The water safety plans framework as is presently, does not fit the realities of self supply systems. Self supply systems are usually non-piped and non-utility managed.

Maintaining safe water quality first necessitates the need to ascertain and monitor the levels of water contaminations. One important type of contamination of concern is microbial contamination. Studies from both developed and developing countries highlight the vulnerability of small systems to microbial contamination, particularly pathogens derived from faecal contamination (Gelinas et al., 1996; Howard et al., 2003; and Fewtrell et al., 2005). The risks of microbial contamination are more significant in shallow aquifers, which may show significant changes in quality in response to rainfall (Godfrey and Howard, 2005). Deeper aquifers tend to have better and more stable microbial quality.

Microbial contamination of water results in major health problems. Microbial contamination is responsible for many of the water borne or water related diseases that remain a major health concern in the world. One of the most deadly and of major concern is diarrhoea. Diarrhoeal diseases (including cholera), which are largely derived from contaminated water, inadequate sanitation and poor hygiene, accounts for about two million deaths (1.7 - 2.5 million deaths) each year, and contribute over 73 million Disability Adjusted Life Years[3] - a measure of disease burden (WHO, 2009). On a global scale, the magnitude of the disease burden due to diarrhoea places the disease sixth in the list of causes of mortality and third in the list of morbidity (JMP, 2005; WHO, 2009). This health burden is primarily borne by the populations in developing countries and by children (Fewtrell et al., 2005).

In developing countries, over 90% of all diarrhoea related deaths occur in children under five years of age (Fewtrell et al., 2005; WHO, 2009). In Sub-Saharan Africa alone, some 769,000 children under five years of age die annually from diarrhoea. That is more than 2000 children's lives lost every day. The implication is that the Sub-Saharan African baby has almost 520 times the chance of dying from diarrhoea diseases relative to a baby born in Europe or United States of America.

The highlighted impact on health generated in part by unsafe water also manifests through loss of schooling to children of school age, and loss of productivity in adult. Hundreds of millions of Africans, Asians and Latin American families are paying everyday in lost income for their lack of access to improved and safe drinking water and sanitation services.

In addition to microbial risks to drinking water, safety may also be compromised by chemical and radiological constituents or heavy metals. Chemical hazards are most likely to result from natural sources or agricultural pollution. Of the natural chemicals, arsenic and fluoride are likely to be the most significant problems facing small systems. Nitrate and pesticides may be found in areas where agriculture is carried out, and where on-site sanitation is close to water points.

[3] Disability Adjusted Life Year (DALY) is a metric measure to quantify the burden of disease. The burden of disease refers to the overall impact of diseases and injuries at the individual level, societal level, or to the economic costs of diseases.

The most cost-effective means of assessing a supply of acceptable drinking water is through the application of risk management (Davison et al., 2005). It is important that risk management is inclusive and covers the whole system from source to consumer.

1.2 The National Context of the Research

The research area is located in Nigeria, West Africa. The Nigerian Government has made considerable investment in water supply programs (JMP, 2006b), yet, 53% (JMP, 2008) of the 140 million people[4] have no access to potable water and safe drinking systems. One reason for such a high percentage is the rapid population growth that has not been accompanied by an increase in the delivery of essential services like water supply. It was estimated that in 2008 only about 65% of the urban and 30% of the small towns' population have access to reliable water supply of acceptable quality (JMP, 2008). The overall effective urban water supply coverage may be as low as 30% of the total population due to poor maintenance and unreliability of supplies (WBR, 2005). Rural water supply coverage is estimated at 30% (JMP, 2008).

The other reasons given for the inadequacies in safe water delivery include the limited investment in the sector despite rapid socio-economic rate of development, a growing industrial base, and poor planning. In addition, haphazard implementation of programs, lack of maintenance and risk management culture, and technically deficient personnel hinder progress (Sangodoyin, 1993).

Frequently in Nigeria, industries, housing estates and individuals are dependent on groundwater resources via boreholes and dug wells to either augment public water supply or serve as their main water source. The most common source of drinking water is groundwater. While many make use of deep wells or boreholes, other households depend on self supply systems such as a family owned hand dug well. Many hand dug well owners share the use of such wells with neighbours. Hence it is

[4] 2006 National population census

common to have two categories of hand dug well users – owners and non-owners. Of the two categories, the latter may have limited access to such supplies.

Contamination of small systems, especially microbial and chemical contaminations can invariably be traced to a variety of human activities. These activities include solid waste landfills, on-site excreta disposal systems, agricultural wastes, and household hygiene behaviours. The unsanitary mode of disposal of wastes, such as defecation in streams and the dumping of refuse in pits, rivers and drainage channels as seen in most Nigerian settlements, is expected to impact surface and groundwater supplies. The degree of contamination however depends on the effectiveness of the waste disposal methods, safety of land use patterns, density of disposal systems in an area, and composition of waste.

In Nigeria no urban community has a sewerage system, except in Abuja (the federal capital) and some areas in Lagos (the commercial capital). As a result, sewage and animal waste either lies stagnant or is disposed of through the storm water drainage systems. The proportions of the population with access to safe facilities for disposal of excreta and wastewater in the country is even lower (29%) than for water supply (WBR, 2005).

Generally, the nature of small and household-managed water supplies is such that the owners and/or the operators of the systems do not have the necessary skills to investigate the potential risks to the water sources. Investigation is in terms of water quality assessment, detection, and monitoring of sources of water contamination. Water source owners and operators do not possess the skill to develop system-specific water safety measures to ensure delivery and consumption of safe water.

In Nigeria, simple protective measures are currently being introduced, for instance lining or covering of wells, and simple chemical household treatment options. There is however no household risk assessment practice in place to ensure safe water delivery through the water systems. Rather, household perception of the wholesomeness of water sources determines the handling (in terms of collection and storage) and usage of water from the sources.

The foregoing therefore calls for an urgent need to develop water safety measures or plans for household self supply systems in order to ensure safe household water from source (collection point) to point of consumption or use.

1.3 The Study Area

The research area is Abeokuta, the capital city of Ogun State in south-western Nigeria. Abeokuta is an ancient township that is gradually being transformed into a modern urban city. The city has about 250,000 people inhabiting more than 50 heterogeneous townships (Onakomaiya et al., 1992). Abeokuta is located in the humid tropics with seven – eight months of bi-modal peak rainy season and an average annual rainfall of 1,200 mm. The area is underlain by the crystalline Basement Complex consisting of igneous and metamorphic rocks. Groundwater however occurs in the fractured and in-situ weathered portion of the rocks (Martins *et al*., 2000).

1.4 Self Supply Systems and Modern Public Water Supply

The importance of small water systems has over the years been overtaken by large scale water supply infrastructures and modern governmental water management policies. The marginalisation of small water systems is attributed firstly to the changed role of the state into major water provider, replacing communities and households as primary units for provision and management of water. Secondly, Government utilities have prioritised the use of capital intensive surface and to a lower extent, groundwater resources (Agarwal and Narain, 1997). The inability of the state to meet up with the ever increasing challenges of water provision has however called for renewed interest in small water supply systems. Embedded in the general description of small water systems are the privately owned or self supply systems. The research focus is on self supply **hand dug wells**.

1.5 Water Safety Plans

Water safety guidance has been developed for large scale water utilities and small community[5] water systems (Donlon, 2004; Godfrey and Howard, 2005; Davison et al., 2005; Mahmud et al., 2007). Water safety planning for both types of system is possible because the responsibility to develop and comply with water safety guidance is placed on source owners (Davison et al., 2005; Schmoll et al., 2006). The ownership of both the public water utilities and community water sources are usually entrenched in governmental and/or non-governmental institutions. These institutions claim responsibilities for provision (and/or funding of public water suppliers), management, and in the case of public utilities, for maintenance and operations. With the advent of water safety plans, same institutions have called for and are involved in ensuring safety measures in the large scale water networks and the community systems. Presently however, water safety guidance for privately owned water sources is yet to be developed.

Similarly, the appropriateness of the WHO water safety plans framework to self supply systems is uncertain. The activities required under the water safety plans are the responsibility of the water supply operators (Schmoll et al., 2006). The designated role and responsibility is not clear for owners of self supply systems. Owners and users of self supply systems usually do not have the technical know-how and/or the expertise needed for such development.

1.6 Research Objectives

The research argues the need for enhanced water safety in self supply systems, examines the relevance of the prescribed WHO water safety planning framework to self supply systems, and recommends appropriate water safety guidance for self supply systems.

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[5] Community water systems is referred to in terms of ownership, irrespective of water systems technology type

The research aim therefore is to develop appropriate generic water safety guidance for self supply systems to ensure acceptable household water quality through the:

- Assessment of self supply systems, in terms of source number, type, water usage, water user perceptions, and number of users;
- Assessment of hazards and risks associated with the identified self supply systems;
- Identification and evaluation of existing 'control measures'[6] relating to self supply systems;
- Assessment of the existing operation, maintenance, and management procedures of sources;
- Appraisal of the development process, content and context of WHO water safety plans, and
- Recommendation of appropriate water safety guidance for self supply systems.

1.7 Research Methodology

The research is a descriptive case study addressing the question of the relevance of the WHO water safety plans framework to self supply systems. The research design fits the embedded single case study in which self supply systems forms the unit of analysis or the case (Yin, 2003; Yin, 2009). The research is composed of both quantitative and qualitative data. Water quality determination and sanitary survey of wells formed the bulk of the quantitative data. Interviews and direct observation of systems operations and handling represents the qualitative data gathering methods.

1.8 Thesis Outline and Structure

The thesis is sub-divided into three main parts. Part I of the thesis explores the research background in four chapters. They are the introduction in chapter 1, the

[6] Those steps in drinking-water supply that directly affect drinking-water quality and collectively ensure that the water consistently meets health-based targets (Schmoll *et al.*, 2006)

literature review (chapter 2), the research area (chapter 3), and the research methodology in chapter 4.

Part II of the thesis presents the results and discussion of the research findings. Chapter 5 sets the scene for the research results and subsequent discussions. The chapter provides the background and the underlying argument, which shaped the structure of the research results and discussions chapters. The results reporting outline is adapted from the development process of the WHO water safety plans. Summaries of findings, the implication of research outcomes to water safety plans, and appropriate recommendations are presented within each results chapter except chapter 8. Chapter 8 presents self supply water safety plans guidance based on the results from chapters 6 and 7. Chapters 6 and 7 describe self supply systems assessments, chapter 9 describes the management practices, and chapter 10 evaluates the identified (control) measures critical to ensuring the source and water safety of self supply systems.

Chapter 11 differs as the chapter is not informed by a water safety plan development process. Identification of critical control measures in chapter 10 results in the identification of possible relevant actors for implementation and enforcement of the control measures. Chapter 11 is thus focused on the identified actors and describes the existing institutional water supply and distribution management structure in the study area. The chapter is critical to the research as it highlights the institutional framework on which the development and possible implementation of self supply water safety plans lies.

Part III of the thesis is the concluding chapter. The chapter reiterates the research objectives and summarises the major research findings. It then goes on to present an integrated discussion reflecting the implication of research outcomes for implementation within the research and the wider context. The chapter provides further guidance for self supply water safety plans, and recommendations for better and future research.

2 LITERATURE REVIEW

This chapter explores and captures as much as possible the background knowledge around self supply systems and water safety plans. The chapter in addition explores related topics such as risk management, and groundwater resources in terms of water quality and contamination. Finally, the chapter highlights some knowledge gaps in relation to the research objectives.

2.1 Self Supply Systems – Definitions and Practice

The term ‘Self supply’, can be defined as an approach to water supply, which concentrates intervention and management at the lowest level[7] and is complementary to conventional communal supply (Sutton, 2004a). Self supply systems include traditional water supplies like scoop holes and dug wells for which there is a strong feeling of ownership among very low density scattered communities, or where additional water treatment is required because of poor performance of communal supplies. In this research, self-supply systems relates to hand dug wells (assets), which may be progressively upgraded, may require household level water treatment and are owned by households with no/restricted access to both communal and/or public water supplies.

Self supply systems are privately owned. Private ownership distinguishes self supply systems from communal or public systems. In contrast to the common connotation of the word ‘private’ however, self supply systems are always used by a group, which goes beyond the individual(s) who initiated and paid for the construction. The upkeep is the responsibility of the person or people who developed the water source with little or no support from the wider user group. Also, any form of payment is uncommon, especially in rural areas, but in trading centres and water scarce regions (urban or peri-urban), it is common for users to pay user fees on volumetric basis (Carter, 2006).

[7] Household or small group level

2.1.1 The concept of self supply systems

The practice of self supply systems has existed since time immemorial-long before the advent of large scale water development systems. In their book, The Dying Wisdom, Agarwal and Narain (1997) documented the rise, fall and potential of India's traditional[8] water systems, and Morgan (1997) described the usage of traditional wells in Africa and part of Europe. Over the years, the changed role of the State to the major water provider, replacing communities and households as the primary units for provision and management of water pushed the use of these systems out of focus in modern water supply management.

Self supply remained a coping strategy at the household level for millions of unserved population (Morgan, 1997; Sutton, 2004b; Foster, 2008). Prevailing pressures on the State however gradually brought back the concept of self supply systems into the limelight. Examples of such pressures include the failure of the State to provide safe water for all in view of the growing population, the negative health impact generated by lack of access to safe water, combined with the time band[9] to meet the Millennium Development Goals.

The recent advent of self supply concept has however not been met with open arms in the water sector. Whilst the advantages of self supply systems to the users are easier access, low cost and ease of management; water sector professionals and policy makers tend to ignore, disapprove or regard the sources as a liability to be replaced rather than improved or augmented (Sutton, 2004c). This attitude is informed by focusing on the perceived disadvantages of the systems, which are poor water quality and construction quality, unreliability (especially seasonality) and lack of safety. These disadvantages informed the 'barriers to overcome', which Carter (2006) explained in his field note. As rightly maintained however, the self supply concept offers improved water quality, opportunity for incremental upgrading of systems, and it has implications for policies, funding, community support networks, replicability

[8] India's traditional sources are scoop holes, dug wells and rainwater harvesting

[9] The year 2015 is set to meet the MDG targets

and sustainability (Morgan, 2003; Sutton, 2004a, b and c; Carter et al., 2005; and Carter, 2006).

2.1.2 Global application

The concept of self supply systems is known, common and widely practised throughout the world (Sutton, 2007). For instance in 1990, over 14.5 million people in the United States had their own private household supply (US Census Bureau, 1990). Approximately 600,000 households in UK still have their own supplies (Sutton, 2007). About a third of Indonesia uses privately owned systems and almost every house in Vietnam, Quang Nam province, had its own well (Noel et al., 2006). Similarly, the potential for self supply systems in Sub-Saharan Africa is huge. Sutton (2007) noted that more than a million people per country in this region depend on self supply sources.

Sutton (2007) and the other authors however failed to highlight similarities and/or differences in practices and scope of self supply systems in various regions of the world or at best between the developed and developing country context. The notion and application of self supply systems is also usually limited to rural water supply. It is also important to note that there is limited documentation on the practice and concept of self supply systems. The available documentations are also authored by a small group of writers.

2.1.3 Potential of self supply systems in Sub-Saharan Africa

Sub-Saharan Africa reports the least coverage rate for safe water in the world (JMP, 2000). In the region, many millions who are unserved with safe water draw their supplies from sources they have found or developed themselves (self supply). Sutton (2007) affirms that hand dug wells exist in large numbers (millions) throughout Africa. She reported that approximately five million people in Mali take water from traditional wells they constructed themselves, either through their own labour or by paying someone else. Morgan's (2003) own experience with self supply systems from Zimbabwe reported that prior to 1980 (before the recognition of the importance of self supply concept), about 30 – 40% of the rural population obtained domestic water from unimproved self supply wells. From the early 1990s onwards, when there was a rapid accelerated program to support the improvements of self supply sources, an estimated 50,000 upgraded shallow wells were serving about half a million people with both domestic and productive water. Morgan's estimate was also cited by WSP (2002) and Carter et al. (2005). In the region however, Ethiopia and Nigeria have the highest numbers of unserved rural poor. While about two million people drink from hand dug wells in Ethiopia, more than 23 million people take water from same sources in Nigeria (Sutton, 2004a).

Table 2-1 presents the number of people drinking from hand dug wells and springs in selected[10] countries of Sub-Saharan Africa (Sutton, 2004a). From Table 2-1, it can be seen that improvements in springs in Ethiopia will benefit more than 20 million people, but will not reduce significantly the time they take to collect water. Upgrading or improving hand dug wells will benefit, in all cases, more than a million people per country and in the case of Nigeria, more than 10 million. These figures represent data from the rural population, implying that they exclude data from the unserved urban, urban poor and the peri-urban. The figures are also derived from available information (MICS[11], DHS[12] and census). Nonetheless, they are generally indicative and suggest the potential of self supply systems in Sub-Saharan Africa.

In recent developments, the importance and potential of self supply systems in urban water supply is acknowledged (Foster, 2008). Foster (2008) noted that the potential growth in self supply is derived from the reality, which rapid growth (4 – 8% pa) of urban population and water demand presents, not just in mega cities but also in the small towns. The author emphasised that potential growth of self supply systems

[10] Countries with available data

[11] Multiple Indicator Cluster Survey

[12] Demographic and Health Survey

should be a key management issue in groundwater development in Sub-Saharan Africa.

Table 2-1: Number of people drinking from hand dug wells and springs in selected* Sub-Saharan Africa countries (adapted from Sutton, 2004a)

Countries	**Total Population** (UN, 2007)	**Number of rural people drinking from springs**	**Rural people drinking from wells**	**% of total population drinking from wells**
Nigeria	140,003,542	-	23,626977	19.5
DR Congo	51,201,000	-	16,675,142	32.6
Mozambique	18,200,000	-	6,236,848	34.3
Uganda	25,633,000	-	6,202,289	24.2
Mali	12,623,000	-	5,184,519	41.1
Tanzania	35,920,000	-	4,414,999	12.3
Chad	8,348,000	-	3,643,902	43.7
Malawi	11,651,000	1,206,787	2,670,759	22.9
Kenya	31,639,000	-	2,473,632	7.8
Zambia	10,698,000	-	2,344,231	21.9
Ethiopia	68,961,000	27,374,207	2,087,863	3.0
Sierra Leone	5,883,889	-	1,954,746	33.2
Cameroon	15,746,000	-	1,674,272	10.6
Cote d'Ivoire	16,365,000	-	1,188,099	7.3

* Countries with available data

2.2 Water Safety Plans – Definitions and Concept

Generally, a water safety plans (WSP) are a systematic assessment of every aspect of providing safe drinking-water (Gregor, 2007). The plans represent an effective means of risk management through a systematic approach, in which risks from catchments to consumers are identified and mitigated (WHO, 2004a). The plans comprise system assessment and design, operational monitoring, and management plans. The objectives are to ensure safe drinking-water through good water supply practice.

Water safety plans have three goals; 1) prevent contamination of source waters, 2) treatment of source waters to reduce or remove contamination that could be present to the extent necessary to meet the water quality targets, and 3) to prevent recontamination during storage, distribution and handling of drinking-water (Davison et al., 2005; 2006). In this research however, WSP are defined as a means of identifying and mitigating risks from self supply water systems from source (hand dug wells) to point of use through systems assessment, operations supervision and management plans to ensure safe drinking water.

2.2.1 Background to water safety plans

Water safety, especially drinking-water safety, became an issue of concern as a result of the global disease burden (WHO, 2008). An estimated 58.8 million DALY plus 88% of the total global disease burden is attributable in part to the consumption of unsafe drinking water supply (Prùss-Űstun et al., 2002; WHO, 2008). Some examples are diarrhoea diseases, infectious hepatitis, typhoid and guinea worm. Outbreaks of these diseases affecting larger or smaller populations are reported from countries at all levels of development and from all types of water supply.

A necessary element in water safety is the maintenance and management of safe water quality to assure that drinking water is free of contaminants. Traditionally, drinking water safety management has focused on compliance with 'end of pipe' standards to evaluate performance of the water supply and to estimate public health risks (Helmer et al., 1999). This traditional approach to water quality management placed a great emphasis on the routine monitoring of water quality, requiring dependence on laboratory analysis. A number of limitations (Table 2-2) are spotted with this approach, but many of the highlighted limitations are focused on public utilities with complex supply network.

The limitations of the end-product compliance monitoring approach, e.g. dependence on laboratory analysis, were progressively recognised (Payment et al., 1991; Hellard et al., 2001; O'Connor, 2002; McCann, 2003; OECD/WHO, 2003; Schmoll et al., 2006). This recognition led to a shift in emphasis to the need for a proactive comprehensive quality assurance approach based on sound scientific evidence and understanding of the risks in a given supply system.

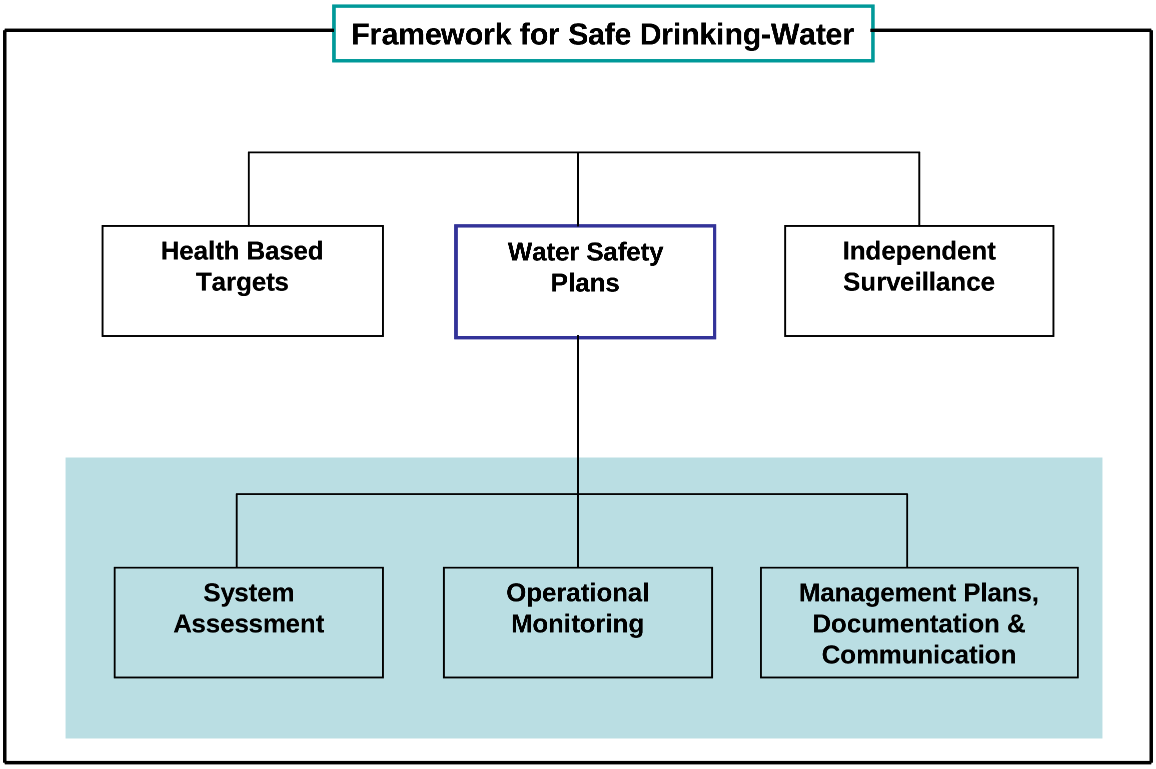
An important quality assurance method formally applied to water supplies is the Hazard Analysis Critical Control Point (HACCP) principles (Howard, 2003a; Schmoll et al., 2006). The use of HACCP for water quality management was proposed by Havelaar, (1994), following international codification of the principles for the food industry. The application of HACCP was further described in relation to specific water supplies. Experiences from codification of the HACCP principles for the food industry and reported applications to specific water supplies (Deere and Davison, 1998; Gray and Morain, 2000; Deere et al., 2001; Howard, 2003a) were used as basis for the WSP approach in the 3rd edition of the WHO Guidelines for Drinking-water Quality (WHO, 2004a).

WSP provide a proactive mechanism for protection of drinking water quality through preventive management to ensure safety of water supplies. The approach formed the basis of development and a major component of a framework, which outlines the institutional, operational and managerial requirements for the effective provision of safe drinking water. The framework (Figure 2-1) is described in the 3rd edition of the WHO Guidelines for Drinking-water Quality (WHO, 2004a; Davison et al, 2005).

Table 2-2: Pros and cons of traditional end-of-pipe water quality management and the water safety plans approach

Traditional end-of-pipe water quality monitoring approach		Water safety plans approach	
Limitations	**Benefits**	**Benefits**	**Limitations**
Focus attention on end-product standards (Schmoll et al., 2006)	Verifies effectiveness of treatment barriers (OECD/WHO, 2003)	Direct focus on public health (Schmoll et al., 2006)	
Dependence on laboratory analysis (Helmer et al., 1999)	Provides important management information (OECD/WHO, 2003)	Assures safety by preventive actions (Davison et al., 2005; WHO, 2004a)	
Ineffective for assessing microbial quality of water (Payment et al, 1991)	Useful check to determine performance deficiency (OECD/WHO, 2003)	Based on multiple-barriers principle to contamination (Schmoll et al., 2006; WHO, 2004a)	
A reactive approach; action is only initiated in response to a failure in relation to the specified quality standard (McCann, 2003)	Allows assessment of any corrective procedures (OECD/WHO, 2003)	Appropriate in areas where laboratory facilities are unavailable or extremely limited (Breach and Williams, 2006)	
Complex contaminant detection process (McCann, 2003)		A participative approach, which encourages representation from all local stakeholders (Gregor, 2007)	
Number of samples taken is typically very small and non-statistically representative (McCann, 2003)		It helps to define the training needs of operators (Garzon, 2006)	
Generally not supportive of public health protection (Hellard et al., 2001; O'Connor, 2002)		It saves cost. For example, 30% cost savings made in Kampala, Uganda (Godfrey and Howard, 2005)	
Operates on single-barrier principle (Schmoll et al., 2006; WHO, 2004a)		Health benefits; (Deere et al., 2001) indicated that quality assurance processes such as WSP can greatly reduce health burdens	
Costly (McCann, 2003)			
Too late to prevent health problems or death			

NB: No known limitation is highlighted in literature for water safety plans



Source: WHO (2004a); Davison et al. (2005)

Figure 2-1: Framework for safe drinking-water

In contrast to the traditional end-product compliance approach the water safety plans framework has a direct focus on public health and assuring safety by preventive actions based on a succession of barriers to contamination across the three main parts of the system; the catchment, treatment works and the distribution network (McCann, 2003). The actions involved are founded on a risk assessment process that has identified the system's problem areas and weak links.

Many authors (WHO, 2004a; Davison et al., 2005; Breach and Williams, 2006; Gregor, 2007) highlighted the various benefits of WSP (Table 2-2), and Kruathong (2007), acclaimed the approach as the most significant water-related public health development since the introduction of chlorine. However, no study to date has highlighted the limitations (if any) of WSP approach to ensuring safe water and water quality management. Likewise, the various benefits were derived mostly from focusing on the WSP applications to public water supplies, with distinct catchment, treatment and distribution networks.

2.2.2 WHO water safety plans

Ten steps were specified by the WHO for the development of water safety plans (see section 5.1). These steps generally require a team of stakeholders to be assembled that understand the system and can undertake an initial assessment of the system with regard to its capability to supply water that meets the specified targets. It is subsequently the responsibility of the team to conduct systems assessment, put in place a structure for monitoring and corrective actions, and periodically verifies that the water safety plans are being implemented correctly and are achieving the performance required.

The WHO water safety plan was defined for utility operated water supplies, for instance using mechanized boreholes, disinfection and piped distribution; or for simple point sources of water where water is collected by hand and transported back home manually (WHO, 2004a; Schmoll et al., 2006). Water safety plans may also be applied to small community water supplies either through a generic water safety plan for a technology type or be developed for an individual supply with structured external guidance (WHO, 2004a; Mahmud et al., 2005). However, the activities required under water safety plans are the responsibility of the water supply operators (Schmoll et al., 2006). The designated role and responsibility can be queried for owners of self supply systems, who usually do not have the technical know-how and/or the expertise needed for such development.

2.2.3 Application of water safety plans

Water safety planning is happening globally, from large municipal water schemes – e.g. in the Pacific (Gregor, 2007) - to small supplies (e.g. Bangladesh, Mahmud et al. (2007)) in remote areas of the world. McCann (2003) catalogued the wide application of water safety plans. From Australia, where the plans are increasingly applied, to United Kingdom where suppliers are commonly using continuous monitoring and other key features of water safety plans. Thailand's established Quality Assurance Certification system on treatment works is another example, while Canada is reported also to be moving in the same direction (McCann, 2003). New Zealand is well advanced in the application and has developed general water safety plan models and guidance documents that could be used by communities as the basis for developing site-specific plans. In Japan and South Africa, HACCP, a basic water safety plan concept was introduced into the water quality management (Jagals and Jagals, 2004; Kato et al., 2006; Yokoi et al., 2006).

Likewise, water safety plan have been implemented in Peru, Uganda, Ghana, Bolivia, Jamaica and Cambodia. The water supply system managed by Empresas Publicas de Miranda, in the southwest of Columbia also tried to implement some elements of the water safety plans approach in designing a tool that not only enabled the utility's administration to acquire an in-depth knowledge of its system, but also helped it to make calculated decisions about investment priorities (Garzon, 2006). As indicated therefore, globally, the goal is the same; access to adequate supply of safe drinking-water, which in turn helps to control water related diseases.

The progress in the application of water safety plans as highlighted is nevertheless slow in developing countries relative to the developed nations. Reports capturing the progress of water safety plans implementation in the developing countries are also not readily available. Likewise, many of the applications highlighted in developing countries are scattered one-off pilot study examples as opposed to on-going progressive applications in developed country context; like in Australia, New Zealand and in the United Kingdom.

2.2.4 Water safety plans in developing countries

A review of the literature identified 18 water safety plans case studies from 15 developing countries across three regions of the world (Table 2-3). Water safety plans have been developed in Asia, South America and Sub-Saharan Africa (SSA). Eight of the 15 countries are in Asia, four countries from South America and three from SSA.

The focus of most WSP in developing countries, as in most developed countries is on public water supplies (Howard, 2003a; Mahmud et al., 2007). Fourteen of the 18 case studies reviewed are from public supply systems in urban (14 cases) and two rural areas. These systems draw their raw waters from surface (rivers and streams), and ground water sources such as boreholes, deep and shallow tube wells. Three of the 18 cases are centred on communal systems (protected dug wells, pond sand filters, rainwater harvesting, shallow tube wells and springs), but none relating to self supply systems (Table 2-3). The omission of self supply systems in WSP development emphasises the need for research in this area because over 140 million people in SSA alone rely on self supply systems (JMP, 2006a).

All nine case studies from Asia dealt with water safety plans which were financed by external funds, and all but one (Thailand) had support[13] from external technical experts. WSP cases in Asia had also been facilitated or driven by external agencies such as Non-Governmental Organizations (NGO), International NGO (INGO), Joint Initiative of INGO and/or Inter Governmental Departments (IGD). Two of the four cases from South or Latin America (Jamaica and Peru) were also externally funded. Two cases (Colombia and Peru) were research driven while the other two cases were facilitated by government (Bolivia) and external agencies (Jamaica). In SSA, the case studies from Uganda are the only ones that are research driven, had support from technical experts, and access to external funds. The Ghana case was motivated by regulation and sponsored by the government through the regulator while the cases reported from South Africa are initiated, facilitated and sponsored by the various service providers.

Generally therefore, five main driving forces were identified for WSP development in developing countries. These included:

[13] Support in terms of experts involvement in WSP planning activities, facilitation and training

- External agencies (8 case studies),
- Government (4 cases),
- Research (4 cases),
- Emergency (1 case) , and
- Service provider initiative (1 country case).

Funding sources had been from external donors; IGD, NGO, INGO and/or joint initiatives (14 cases), individual government (3 cases), and service providers (1 country case).

Table 2-3: Summary of water safety plans (WSP) case studies in developing countries

S/N	Ref.	Region	Country	Type of report	Duration (Year)	Type of system	Driver	Funding
1	Rouse (2007)	Africa	Ghana	R	1	PS	Regulation	Regulator - Government
2	Davison et al. (2005)	Africa	Uganda	P	NS	PS	Research	Ext. IGO
3	Howard (2003a)	Africa	Uganda	R	1	CS	Research	Ext. IGO
4	IWA Intern	Africa	South Africa	R	NS	PS	SP initiative	Service provider
5	Garzon (2006)	South America	Colombia	R	NS	PS	Research	Government
6	WSP, Tarija-Bolivia	South America	Bolivia	P	2	PS	Government	Government
7	Paho et al. (2007)	South America	Jamaica	P&R	2	PS	External agency	INGO/IGO
8	McClain et al. (2001)	South America	Peru	R	0.1	CS	Research	Ext. IGO
9	Unknown (2005)	Asia	Bangladesh	P	1	PS	Government	IGO
10	Mahmud et al. (2007)	Asia	Bangladesh	R	1.5	CS	Government	IGO
11	Kruathong (2007)	Asia	Thailand	P	0.16	PS	Emergency	INGO
12	Gregor (2007)	Asia	Pacific Islands	R	~ 4	PS	External agency	NGO
13	Mckie et al. (2006)	Asia	St Lucia	NS	NS	PS	External agency	NGO
14	WHO Newsletter (2006)	Asia	Vietnam	NS	NS	NS	External agency	NGO
15	SOPAC/WHO (2007)	Asia	Tonga	NS	NS	PS	NS	NS
16	SOPAC/WHO (2007)	Asia	Cook Islands	NS	NS	PS	NS	NS
17	SOPAC/WHO (2007)	Asia	Vanuatu	NS	NS	NS	NS	NS
18	SOPAC/WHO (2007)	Asia	Palau	NS	NS	NS	NS	NS

Ext.: External; R: Review paper; P: Actual plan; PS: Public (water) system; CS: - Communal (water) System; IGO: Inter Governmental Organization; SP: Service Provider; NGO: Non Governmental Organization; INGO: International Non Governmental Organization; Duration: The number in years taken for WSP development; NS: Not specified

2.3 Risk Assessment Methods

Two distinct risk assessment approaches are being used by water utilities and research organizations. They are quantitative risk assessment (QRA) and qualitative approach (Miller et al., 2005). QRA involves the selection of assessments, measurement of endpoints and the comparison of endpoint water quality measurements to guideline value. Qualitative approaches on the other hand involve the use of expert judgement and local knowledge in the assessment and prioritization of contaminants, pollution sources or hazard events (Godfrey and Howard, 2005; Miller et al., 2005). The methods used in qualitative risk approach can however be generic (e.g. Standards Australia 1999) or the HACCP system, which informed water safety plans.

There are many procedures for risk assessments, which vary over different components like input information, driving compliance frameworks, base categorization (hazard or hazardous events based), and if they are quantitative or qualitative in assessment. However, five main types of risks assessment methods can be identified (Deere et al., 2001):

- Conceptual descriptions of the cause and effect relationships that lead to risks arising from a particular activity or scenario. Miller et al. (2005) regarded this method as non-quantitative, but valuable as educative and illustrative tools.
- Qualitative, subjective risk ranking models. These models are used to rank scenarios, events or options in terms of risk or impact, but do not provide estimates of actual risk.
- Semi-quantitative objective risk ranking models. The models involve the use of objective data like occurrence frequencies or receptor population sizes.
- Point-estimate quantitative risk assessment models. These are useful in screening-level assessments for single hazards and endpoints.
- Probabilistic quantitative models. These employ randomised frequency distributions to represent one or more element. They provide useful representation of the uncertainty and variability in estimates.

What is however not clear in the literature is the difference between the terms risk assessment approaches and risk assessment methods/methodologies. The two terms are used interchangeably. Within this research however, risk assessment approaches is used to imply a higher order method under which risk assessment methods or procedures are placed.

2.3.1 HACCP

HACCP employs the qualitative subjective risk ranking method. It originated from engineering risk management approaches and first became established to assess risks to food safety. It has now been widely accepted, and applied to drinking water quality management as adapted in WSP. The prerequisite to HACCP is the establishment of good operational management practices, which involves five basic steps with seven principles (Box 2-1).

Although WSP are based on the principles of HACCP, Miller et al. (2005) pointed out the elements, which make the plans more robust and credible. The key elements are the health-based targets on which the system's assessments are based and the public health surveillance. However, while HACCP can be adapted for use into any of many disciplines such as engineering and food industries, WSP is tailored to focus available financial and institutional resources on the risks that are most relevant to public health in a specific setting, water quality management.

HACCP	
Basic Steps	
1	Assemble team
2	Describe product (water)
3	Identify intended use
4	Construct flow diagram (of water system from source to distribution)
5	Confirm flow diagram (Confirm the observed water system with drawn diagram)
Principles	
1	List all potential hazards; conduct hazard analysis and determine control measures
2	Determine critical control points (CCP)
3	Establish critical limits for CCP
4	Establish a monitoring system for each CCP
5	Establish corrective actions for derivations that may occur
6	Establish verification procedures
7	Establish record-keeping and documentation

Adapted from Miller et al., 2005 and Yokoi et al., 2006

Box 2-1: The basic steps and principles involved in HACCP

2.3.2 Hazard identification strategies

Davison et al. (2005) defined a hazard as any biological, chemical, physical or radiological agent that has the potential to cause harm. The same authors claimed that hazards may be introduced throughout the supply chain, from source to point of use. They equally defined hazardous events as incidents or situations that can lead to the presence of a hazard and can cause contamination directly or indirectly. In their view, which was also reiterated by WHO (2004a), an effective risk management will require identification of all potential hazards, their sources, possible hazardous events and an assessment of the risk presented by each.

However, approaches to hazard analysis vary. The variation is informed usually by the choice between hazard assessment and hazardous event analysis. Schmoll et al. (2006) suggested that the hazardous event approach has the advantage of considering the probability of the event occurring and hence is more effective than considering the specific hazards to the system. Miller et al. (2005), on the other hand claimed that the usage of hazard identification as initial screening assessment before embarking on a second stage of hazardous event analysis is more appropriate. The latter view is shared by the WHO WSP in which hazardous events are considered after hazards are identified and listed (Davison et al., 2005).

Similarly, differing views exist in literature on how best to identify contaminations. This may not be unconnected with the lack of consensus on whether to base risk assessment on hazards or hazardous events approach. According to WHO (2004a), hazards are identified through water quality data or by conducting water quality analysis in the absence of existing quality data. To identify contamination through hazardous events approach, some authors (WHO, 2004a; Davison et al., 2005) promoted sanitary surveys while others (Schmoll et al., 2006) prefer the combination of sanitary surveys, systems vulnerability, and pollutant behaviour assessments. Some other authors (Howard et al., 2003; Miller et al., 2005; Cronin et al., 2006) claim that coupling water quality monitoring with sanitary risk inspections is a more useful method.

2.3.3 Sanitary surveys

A sanitary survey is an onsite review inspection of water supplies from source to point of use. The survey includes the inspection of system operations and maintenance, to evaluate systems adequacy for safe water production or supply (EPA, 1999). The idea, according to Lloyd and Bartram (1991), is to systematically list every fault observed at each point considered as a sanitary risk factor. Identifiable points of sanitary risk are then weighted equally to develop a risk score based on the sanitary inspection. Generally, sanitary survey forms are used. The forms contain assessment criteria for a particular water supply. Standardised forms for sanitary surveys and inspections are available in a number of documents, and are linked to the WHO Guidelines for Drinking-water Quality (Lloyd and Helmer, 1990; Lloyd and Bartram, 1991; WHO, 1997; Howard, 2002; WHO, 2004a; Davison et al., 2005).

The assessment criteria in many of the available examples of standard sanitary inspection forms are scored on a two-way ‘yes or no’ answer (Box 2-2). The possibility of variations between the set out criteria in the forms and the observed sanitary faults are not provided for within the two-way answer system. Aside the subjectivity involved in sanitary survey, this ‘yes or no’ scoring system assumes a rigid correspondence between the assessment criteria and the observed sanitary faults. Hence the scores may not always represent the correct sanitary problem. The use of this type of scoring system may therefore either exaggerate or underplay particular risk factors.

I. Type of Facility: **DUG WELL WITH HAND PUMP / WINDLASS**

1. General information : Zone: ……………………………
   Location: ……………………………………………………………
2. Code Number: ………………………………………………………
3. Date of visit: …………………………………………………..……
4. Water sample taken? …………. Sample No.: ………… FC/100ml: …

II. **Specific Diagnostic Information for Assessment**

	Risk
1. Is there a latrine within 10 m of the well?	Y/N
2. Is the nearest latrine uphill of the well?	Y/N
3. Is there any other source of pollution within 10 m of the well? (e. g. animal breeding, cultivation, roads, industry, etc)	Y/N
4. Is the drainage faulty allowing ponding within 2 m of the well?	Y/N
5. Is the drainage channel cracked, broken or needs cleaning?	Y/N
6. Is the fence missing or faulty?	Y/N
7. Is the cement less than 1 m in radius around the top of the well?	Y/N
8. Does spilt water collect in the apron area?	Y/N
9. Are there any cracks in the cement floor?	Y/N
10. Is the hand pump loose at the point of attachment to well head?	Y/N
11 Is the well-cover unsanitary?	Y/N

Total score of risks: ………../ 11

Risk score: 9 – 11 = very high; 6 – 8 = High; 3 – 5 = Medium; 0 – 3 = Low

III. **Results and Recommendations:**

The following important points of risk were noted:
(List nos. 1 – 11)

Signature of Health Inspector/Assistant: ………………………………………………..…

Comments:

Source: Davison et al., 2005

Box 2-2: Example of a standard sanitary survey form with a 'yes or no' answer system

2.4 Risk Management

Risk management is generally the overall systematic approach to analysing risk and implementing risk controls. Risk management is usually defined to suit the context of interest but the underlying principle, which is risk mitigation, is the same. In the context of water safety, risk management is simply identifying potential sources of contamination, and managing barriers to prevent contamination reaching the end users (Fewtrell and Bartram, 2001).

The risk management definition given by Fewtrell and Bartram (2001) would be satisfactory in an ideal situation where for instance all scenarios by which contamination could occur are understood; barriers would be effective at eliminating the risk from contamination sources; any barrier failure detected and corrective action taken; and individuals with the power to manage risk would have risk management as their primary interest and behave or act appropriately. The case in reality may be the reverse scenario of the ideal. The arrangement of contamination sources and barriers is very complex and hardly ever perfectly understood. Barriers are rarely absolute barriers and function primarily to reduce risk and not to eliminate risk. Finite resources limit the ability of contamination sources to be controlled at source or via barriers, and individuals with the power to manage risk may have conflicting interest; also people cannot be controlled or relied upon totally.

The complex reality therefore necessitates the use of systems to manage risk (Fewtrell and Bartram, 2001). The need for systems risk management resulted in the development of systems risk management approaches like the HACCP, which has been found to be an acceptable framework for guiding the process of risk management in water supplies (Havelaar, 1994; Gray and Morain, 2000). However, the management of risk in a complex water supply requires not only a systems approach but also a risk management culture.

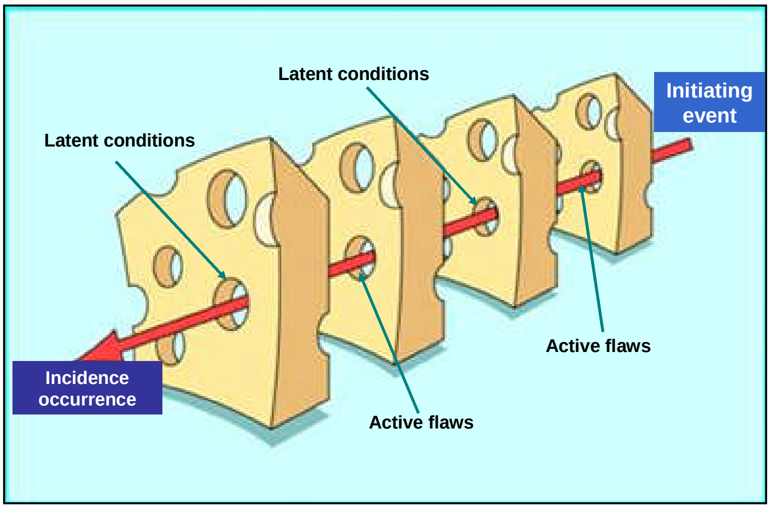
2.5 Risk Management Culture and Water Safety

Effective and competent risk management is a function of the development of a risk management culture (Pollard et al., 2006). A risk management culture entails proactive risk management, and the recognition that the knowledge on which risk-based decisions rely needs coordination and resourcing. Risk management culture perspective is borne from the fact that apart from the assessment of risks, what counts is managing risk competently, wisely, and by targeting the risk critical elements of a system for maximum risk reduction. Managing risk thus requires vigilance at all levels of and within the water supply chain, focused around achievable goals that are communicated within and between relevant stakeholders (Pollard et al., 2006). From the author's viewpoint therefore, vigilance, proactiveness, communication, and coordinated knowledge are key elements of a risk management culture.

However, given the Walkerton[14] water safety tragedy, Hrudey and Hrudey (2004), and Hrudey et al. (2006) argued that even with high levels of vigilance, accidents may still occur. Reason (2000) in agreement with Fewtrell and Bartram (2001) further pointed out that accidents have complex root causes, which lie dormant within the system until a final defence fails that completes the critical path to an accident (Figure 2-2). Vigilance is crucial but not enough.

Proactiveness anticipates when things might go wrong and enable quick action to take place. Though proactiveness is important, the risk management capability maturity model developed by MacGillivray et al. (2007) ranked proactiveness at least two steps lower than the best practice. Consequently effective or best practice risk management requires more than proactiveness.

[14] In May 2000, bacterial contamination of municipal water in Walkerton, Ontario, resulted in a tragedy of at least seven deaths and 2300 reported illnesses (Salvadori et al., 2009).



Source: Reason, 1997; 2000

Figure 2-2: Reason's Swiss cheese model of failure

According to the capability maturity model, effective and healthy risk management requires not only vigilance and proactiveness but also a safety culture. Safety culture (or best practice) is the capability of learning, adapting, and using experiences to correct problems and change the nature of operation (MacGillivray et al., 2007). These authors implied safety culture as not just another element in risk management culture, but as the best practice. Developing a risk management culture (mindfulness) is therefore hinged more on the adoption and development of a safety culture.

Taylor (2005) explains that the development of a risk management culture that is sustaining and continues to learn requires a number of factors. These factors include leadership, procedures, and an appetite for conservative decision-making where safety is put first even under pressure. Other factors include the ability to prioritise, a culture of sharing reported close calls, and systematic competency checking. Of the highlighted factors, it is understandable that leadership and management are important to establishing the right culture. IOSH (2004) however opined that the first requirement in generating a risk management culture is to create a reporting culture. A prerequisite to reporting culture is the capacity to manage knowledge.

In the delivery of water safety, Pollard et al. (2006) opined that proactive development of competencies and behaviours is essential. Ultimately therefore, knowledge management and reporting culture, which leads to a healthy risk management culture, and the optimised safety culture would require proactive development of competencies and behaviours within relevant stakeholder groups to achieve best practice risk management.

2.6 Groundwater Resources

Schmoll et al. (2006) describes groundwater as the water contained beneath the surface in rocks and soils, and is water that accumulates underground in aquifers. The resource constitutes 97% of global fresh water and is an important source of drinking water in many regions of the world.

2.6.1 Reliance on groundwater resources

The proportion of groundwater in drinking-water supplies for Austria, Denmark and Hungary is given as 99%, 98%, and 95% respectively (EEA, 1999; UNECE, 1999). More than 50% of potable water supplies are from groundwater in India, China, Thailand and Bangladesh. In rural areas of the United States of America, 96% of domestic water comes from groundwater (USEPA, 2004). Similarly, many millions of people in the rural and peri-urban in Africa and Asia are dependent on groundwater. Pedley and Howard (1997) estimated that as much as 80% of the drinking-water used by these communities is from groundwater sources.

The huge dependence on groundwater sources where it is available is unconnected with its perceived advantages over the surface waters. It may be conveniently available close to where it is required. It can be developed at relatively low cost and in stages to keep pace with rising demand and financial ability (Schmoll et al., 2006). Groundwater is also generally assumed to be a relatively safe drinking water source due to the protection and filtering effect of the soils and sediments over the waters. In spite of these advantages however, it is a known fact that groundwater can easily be contaminated (Waller, 1994; Pedley and Howard, 1997; Howard et al., 2003; Cronin et al., 2006). Chapelle, (1997) similarly figured that groundwater pollution pathways and processes are not readily perceived. Chapelle's view highlights a key issue in the use of aquifers as drinking-water source, showing that particular attention is needed to ascertain whether the general assumption of groundwater being safe to drink is valid in individual settings. Additional quality concerns result also from over exploitation of this resource.

2.6.2 Groundwater Contamination

Though the soil provides an excellent structure for filtering out particulate matter, like surface waters, groundwater resources are susceptible to contamination (Waller, 1994). Underground water can get contaminated from both naturally occurring aquifer constituents and (more importantly) human activities; industrial, domestic and agricultural chemicals from the surface. The resource can also deteriorate due to inadequate source protection and poor resource management (Pedley and Howard, 1997). Contamination can be in the form of chemical, radiological and microbiological elements in quantities large enough to cause harm, especially public health problems. Contaminated groundwater can thus contribute to high morbidity and mortality rates from diarrhoeal diseases and sometimes lead to epidemics. Evidence of the health impact abounds all over the world (Pedley and Howard, 1997; Health Canada, 2000; Nasiyama et al., 2000; Barwick et al., 2000; Lee et al., 2002; Craun et al., 1997; 2003; and 2004;). What is however not very clear but crucial to knowledge is the understanding of the contamination mechanisms to correctly identify necessary interventions.

Some attempts were made to gain insight into the invisible groundwater pollution pathways and processes. ARGOSS (2001) pointed out that there are two possible routes for microbial[15] contamination of groundwater sources; the aquifer route (such

[15] Most critical to safety and human health

as latrine or leaking sewer), and the well head pathway such as poorly protected wellheads. These routes have regularly been associated with groundwater contamination (Howard et al., 2003; Cronin et al., 2006). Other identified pathways are localised pathways like on-site defecation (Godfrey et al., 2005) and direct ingress (Gelinas et al., 1996). Direct ingress is associated with introduction of contaminants directly into water source e.g. flooding or contamination through water drawing buckets.

It is interesting to note that rather than acknowledging emerging groundwater contamination pathways and the mechanism involved therein, many studies are focused on ranking routes. For instance, Melian et al. (1999) presumes that the aquifer route of contamination predominates, while Godfrey et al. (2005) indicated that localised pathways are likely to be the primary cause of contamination rather than contamination due to aquifer routes. Similarly, Howard et al. (2003) found localised pathways (proximity and location of contamination source) to be of more importance to well head route, while studies in Bangladesh claimed that well head route is more important than subsurface leaching or localised pathways (Ahmed et al., 2002). Importantly, it is necessary to suggest that research efforts in this context should be harnessed towards understanding the mechanism behind every route that has been associated with contamination of groundwater.

Understanding pollution pathways in groundwater is critical to taking action to prevent further pollution. It is equally crucial to identify appropriate remedial actions. Cronin et al. (2006), after discovering that groundwater microbial contamination may be reduced by barriers such as well head protection areas and well disinfection, opine that research focus should be solely on breaking the specific pathways between potential sources of contamination and ground water sources. This summation has however been taken on board in water management as exemplified by the risk assessment and management approach that is being promoted through the water safety plans and in this research.

2.7 Contamination indicators

Groundwater contamination indicators are examined under three sub-headings. These are non-microbial parameters, microbiological indicators and nitrate as groundwater pollution indicator. The indicators that are of interest to this research are discussed within the relevant headings**.**

2.7.1 Non-microbial parameters

Non-microbial parameters are useful in risk event assessments (OECD/WHO, 2003). Measurements of the non-microbial parameters, relative to most microbial indicators, are inexpensive, require average skill and can be performed routinely in laboratories or easily conducted on site. Apart from the speed and simplicity of measurements, the parameters are used to trigger both further investigations, and control measures like shutdown of well or increase groundwater treatment. Monitoring of the non-microbial parameters thus serves as a useful tool in risk preventive approaches. The non-microbial parameters for groundwater monitoring that are of interest to this research are turbidity, temperature, pH and electrical conductivity. These parameters are discussed in turn.

Turbidity

Turbidity is a measure of the relative clarity of water (Allen et al., 2008). It measures suspended solids, and it is generally the most applicable and widely used non-microbial parameter that can provide the most significant water quality data throughout water abstraction and treatment process (OECD/WHO, 2003). Turbidity is often determined by measuring the amount of light scattered by the particulate matter in the water using a nephelometer. Where a high level of sensitivity is not required, a simpler method based on transparency can be used. The unit of measurement is defined in Nephelometric Turbidity Units (NTU).

Most ground waters have stable turbidity relative to surface waters and any change reflects a major event that needs to be investigated and corrected (Allen et al., 2008). High turbidity in groundwater usually originates from soil material, but also from rapid ingress of surface water, runoff or surface percolate. This makes turbidity an easy and rapid indicator of the presence of contamination. It should however be noted that the use of turbidity as an indicator of groundwater quality changes is generally tied with the causes of turbidity in water. Frequent causes of turbidity are suspended and colloidal matter such as clay, silt, and finely divided organic and inorganic matter, plankton and other microscopic organisms. Rapid movements during recharge periods or rainfall events will displace sediments and turbidity can be the indicator for such changes. Similarly increases in turbidity are often accompanied with increases in the numbers of pathogens (Waite, 1997). Turbidity is not associated specifically with microbial contamination, and as such does not categorically indicate pathogen presence.

Temperature

Temperature measurements at different depths in water wells provide information on the characteristics of major inflows. Temperature is also probably the most important factor influencing the inactivation of bacteria and viruses in water and the environment (Schmoll et al., 2006). Laboratory studies demonstrated a negative correlation between water temperature and the survival of, for example, coliform bacteria. Some studies claimed that the influence of temperature on the migration of bacteria and viruses is unknown (Bitton and Harvey, 1992; Robertson and Edberg, 1997). However, recent studies suggest that inactivation rates of viruses at temperature higher than 25^{o}C is one order of magnitude higher than at 5^{o}C (Schmoll et al., 2006). Findings have also shown that rapid changes in temperature are a signal for microbial investigation, such as testing for *E. coli and clostridium perfringens* (OECD/WHO, 2003).

pH

pH indicates, by numerical expression, the degree to which water is alkaline or acidic on a scale of zero to 14 where zero is most acidic, 14 the most alkaline and seven is neutral. Generally, high pH causes a bitter taste and encrusts water pipes in water-using appliances. On the other hand, low pH water corrodes or dissolves metals (USGS, 2007).

For groundwater resources, Robertson and Edberg (1997) noted that the pH of most unpolluted groundwater usually fluctuates within 6.5 – 8.5. They further infer that this pH range is unlikely to result in significant changes in the mobility of microbes. However, this assumption may not be valid for contaminated groundwater. Where groundwater is exposed to contamination from a variety of sources like sewage, Schmoll et al. (2006) affirms that pH may emerge a dominant factor in the mobility of pathogens. Similarly, some authors suggest that pH indirectly influences the survival of pathogens by controlling adsorption to soil materials. Adsorption to surfaces ultimately reduces the inactivation rate of pathogens. Low pH typically increases virus sorption and encourages adsorption of most enteric bacteria to soils, and the aquifer matrix of ground waters. High pH causes desorption, which facilitates greater pathogen migration (Schijven and Hassanizadeh, 2000; Bitton and Harvey, 1992). Routine monitoring of groundwater pH therefore can provide a valuable insight to groundwater quality status as any unusual change may reflect a major event (OECD/WHO, 2003).

Electrical conductivity

Conductivity is used to reflect total dissolved solids concentration and can be applied rapidly in field or on site. Dissolved solids occur naturally but also enter ground waters through man made sources such as landfill, leachate, feedlots or sewage. Relatively low saline waters (fresh waters) can thus become more saline or mineralised with the introduction of most waste waters. Although conductivity mainly reflects the mineral content of water, a USGS (2007) report confirms that marked change in conductivity provides an indication of contamination.

2.7.2 Microbiological indicators

WHO (2003) defined a reference or indicator pathogen as an organism whose severity of impact and persistence in water is such that its control would provide confidence that health risks from pathogens of a similar nature had also been controlled. Box 2-3 highlights the criteria an organism must meet to qualify as a microbial indicator.

The criteria

- The indicator should be absent in unpolluted water and present when the source of pathogenic microorganism of concern is present
- The indicator should not multiply in the environment
- The indicator should be present in greater numbers than the pathogenic microorganisms
- The indicator should respond to natural environmental conditions and water treatment processes in a manner similar to the pathogens of concern
- The indicator should be easy to isolate, identify and enumerate.
- The test should be inexpensive thereby permitting numerous samples to be taken
- The indicator should not be a pathogenic microorganism (to minimise the health risk to analysts).

Source: OECD/WHO (2003)

Box 2-3: Criteria for microbial indicators

Microbial indicators of contamination have been in use for decades as an index of faecal pollution and therefore, likely health risks (OECD/WHO, 2003). The microbial indicators discussed below are however those of interest to this research, and are *Escherichia coli* and *Clostridium perfringens*.

Escherichia coli

OECD/WHO (2003) describes *Escherichia coli* (*E. coli*) as a taxonomically well defined member of the family Enterobacteriaceae that is characterised by possession of the enzymes B-galactosidase and B-glucuronidase. It grows at 44-45^{o}C on complex media, ferments lactose and mannitol with production of acid and gas, and produces indole from tryptophan. It was noted that some strains can grow at 37^{o}C but not at 44

– 45^{o}C and some do not produce gas. *E. coli* does not also produce oxidase or hydrolyse urea.

The source of *E. coli* is reported in literature with varying, but not contradictory points of view. OECD/WHO (2003) reported that *E. coli* is abundant in human and animal faeces, attaining concentrations of 10^9 per gram in fresh faeces. They further claimed *E. coli* is found in sewage, treated effluents and all natural waters and soils subject to recent faecal contamination from humans, wild animals, or agricultural activity. Hazen and Torranos (1990) and Fujioka et al. (1999), on the other hand suggested that E. coli may be present or even multiply in tropical waters not subject to human faecal pollution, stressing that the organism is not peculiar to sources of human origin. Haas et al. (1999) claimed that the major source of *E. coli* is from animals (goats, pigs, chickens), with cattle being the principal reservoir. The most interesting discovery about the source of *E. coli* was however made by Dufour (1977). Dufour found *E. coli* to be the only member of the coliform group that is found in faeces of warm-blooded animals and it out numbers the other thermotolerant[16] coliforms in both human and animal excreta. Dufour's discovery implies that the common source of the pathogen is faecal pollution, a factor that contributed to making *E. coli* a universal microbial indicator of pathogens.

Although faecal coliforms like *E. coli* have several drawbacks as indicators, OECD/WHO (2003) noted that they have historically been very useful and are undoubtedly the most used microbial parameters for testing drinking water quality. The author further claimed that their use has led to significant improvement in the safety of drinking water world-wide and adopted in the WHO guidelines for drinking water quality and all national drinking water quality standards. The WHO (1993) emphasise that *E. coli* is the parameter of choice for monitoring drinking water quality with thermotolerant coliforms as an alternative.

[16] Thermotolerant coliforms are the coliforms that prefer warm temperatures.

One of the main reasons for the success and the preferred usage of *E. coli* is the ease of the assay. The other reason given by OECD/WHO (2003) is the low cost. The ease and low cost of the assay makes it possible to test water sources for *E. coli* frequently.

E. coli is detectable by simple, inexpensive cultural methods that require basic routine bacteriology laboratory facilities. The detection of *E. coli* however requires well trained and competent laboratory workers as it can pose a health risk since some of the strains are pathogenic (OECD/WHO, 2003). Apart from laboratory testing of *E coli*, portable kits are available for field measurements of *E-coli*. It should however be noted that *E coli* has been a microbial indicator for decades, yet a rapid reading measuring device is yet to be produced for field measurement or in-situ detection at the water resource sites.

Clostridium perfringens

Clostridium perfringens is typical of the sulphite-reducing clostridia, an anaerobic, and spore forming organism (OECD/WHO, 2003). *Clostridium perfringens* is normally present in faeces, but in smaller numbers than *E. coli*. Unlike the other sulphite-reducing clostridia however, *C. perfringens* is exclusively of faecal origin, a factor that made it a preferred parameter. Past studies by Godfrey and Howard (2005) and Ashbolt et al. (2001) provided examples of the use of *C. perfringens* as microbial indicator. Ashbolt et al. (2001) particularly drew attention to using *C. perfringens* as indicator in assessing pathogen removal through water treatment processes.

The presence of *C. perfringens* in ground waters in the absence of *E. coli* points to pollution at some time in the past and suggests the source may be liable to intermittent contamination. This is because *C. perfringens* can survive for extended periods of time by producing spores (Schmoll et al., 2006; OECD/WHO, 2003). As a result, *C. perfringens* is not recommended for routine monitoring of water sources or the distribution system because they may be detected long after and far from the pollution event, leading to false alarm. The authors (Schmoll et al., 2006; OECD/WHO, 2003) also noted that *C. perfringens* spores are quite resistant to disinfection. *Clostridium* *perfringens* spores are thus expected to be removed by some form of filtration as terminal disinfection is unlikely to inactivate them. Schijven et al. (2003) however warned that the removal is dependent on the number of spores that accumulate in the porous medium.

Methods for detection of Clostridia are relatively easy to perform and international standardised methods are available (ISO 6461-1; 6461-2). Detection of *C. perfringens* requires basic routine bacteriology laboratory. The routines are not normally a health risk for laboratory workers but OECD/WHO (2003) warned that Clostridia are pathogenic and if carelessly handled can give rise to food poisoning and wound infections. Generally however, detection, removal, and monitoring of Clostridia are associated with large scale water utilities with defined treatment processes. It is nonetheless important to focus on detection, removal, and monitoring of these pathogens in small systems with limited or no defined treatment processes and facilities.

2.7.3 Nitrate-NO_3 as contamination indicator

Due to high solubility of most nitrate salts, nitrate, of all the nitrogen species[17], is a chemical of concern as groundwater pollutant (Schmoll, et al., 2006). Nitrate is a major concern to public health because of its potential health effects on bottle-fed babies (WHO, 1996). Other generated public health concerns are due to large inputs of the chemical to groundwater in areas with intensive agriculture and/or on site wastewater disposal, and its tendency to accumulate in aquifers. As contributor to the public health burden, nitrate is ranked 3rd, behind water borne pathogens and naturally occurring groundwater constituents like fluoride and arsenic (Schmoll et al., 2006).

Elevated nitrate concentrations in ground waters do occur naturally, particularly in some arid parts of the world (Barnes et al., 1992; Edmunds and Gaye, 1994). However, high nitrate levels or nitrate contamination in groundwater are generally

[17] Nitrogen species include ammonia, nitrate, nitrite and urea

attributed and associated with the use of animal manures and fertilizers on agricultural lands (Close et al., 2001; Sullivan et al., 2005; Schmoll et al., 2006) and to on site sanitation systems like pit latrines (Hutton et al., 1976; Chidavaenzi et al., 2000; ARGOSS, 2001; Sullivan et al., 2005).

Nitrate is frequently used as a marker of sewage input to groundwater resources, and as an analytical indication of human excreta and sewage in groundwater (Schmoll et al., 2006). However the use of nitrate levels as an indicator has its drawbacks. Barrett et al. (1999) and ARGOSS (2002) found nitrate levels to vary with season. Another drawback is that nitrate in groundwater is derived from other sources (natural, agriculture). As a result, more reliable tools to nitrate have been reported. Examples include nitrate to chloride ratio (Morris et al., 1994), isotopic nitrogen ratios (ARGOSS, 2002), trace metals (Ashbolt et al., 2001), 1-aminopropanone and caffeine (SWRC, 2001) to mention a few. However, the reliability of each reported tools are equally in question. For instance, nitrate to chloride ratio is found to vary with season, particularly in shallow groundwater (Schmoll et al., 2006). Caffeine, a non-adsorbed and conservative indicator of sewage inputs, is not readily detected in groundwater (SWRC, 2001) and ammonia, another proposed tool which may be indicative of recent sewage contamination of shallow groundwater, is rapidly oxidized to nitrate (Schmoll et al., 2006). Consequently, nitrate remains a frequently used groundwater pollution marker.

2.8 Summary - Knowledge Gaps and Research Objectives

The presented review identified a number of gaps in what is currently known about self supply systems, water safety plans, risk assessment and other relevant topics. The knowledge gaps relating to the research objectives are summarised in the following text.

In the first instance, the concern for self supply systems is focused on the systems playing a role in water service delivery to the rural poor; despite reports indicating that self supply system practices is common and well known globally. This research examines the need for water safety plans for self supply systems, and provides evidence of self supply systems practices in an urban area. This research argues that self supply system is a coping water supply strategy of not only the rural poor but also of the unserved population in urban environments.

Self supply systems and the systems' yielding safe drinking-water receives little attention in literature relative to public and communal water systems. Documentation on self supply systems is provided by limited numbers and a small group of authors. The research emphasises that self supply systems should be seen as the third angle, which completes the water supply triangle with the public and communal water systems as the other angles.

The limited attention to self supply systems is also reflected in the absence of a relevant or appropriate water safety plans for self supply systems. The development and application of water safety plans until now is largely focused on public utilities and communal water systems with defined treatment processes and distribution. The water safety plans framework as it presently stands do not recognise or take into consideration the realities of self supply systems. The management aspects of the water safety framework particularly represent grey areas for self supply systems. This research reviews the grey areas and recommends an appropriate water safety framework for self supply systems and in doing so provides evidence of how safe water can be ensured in self supply systems.

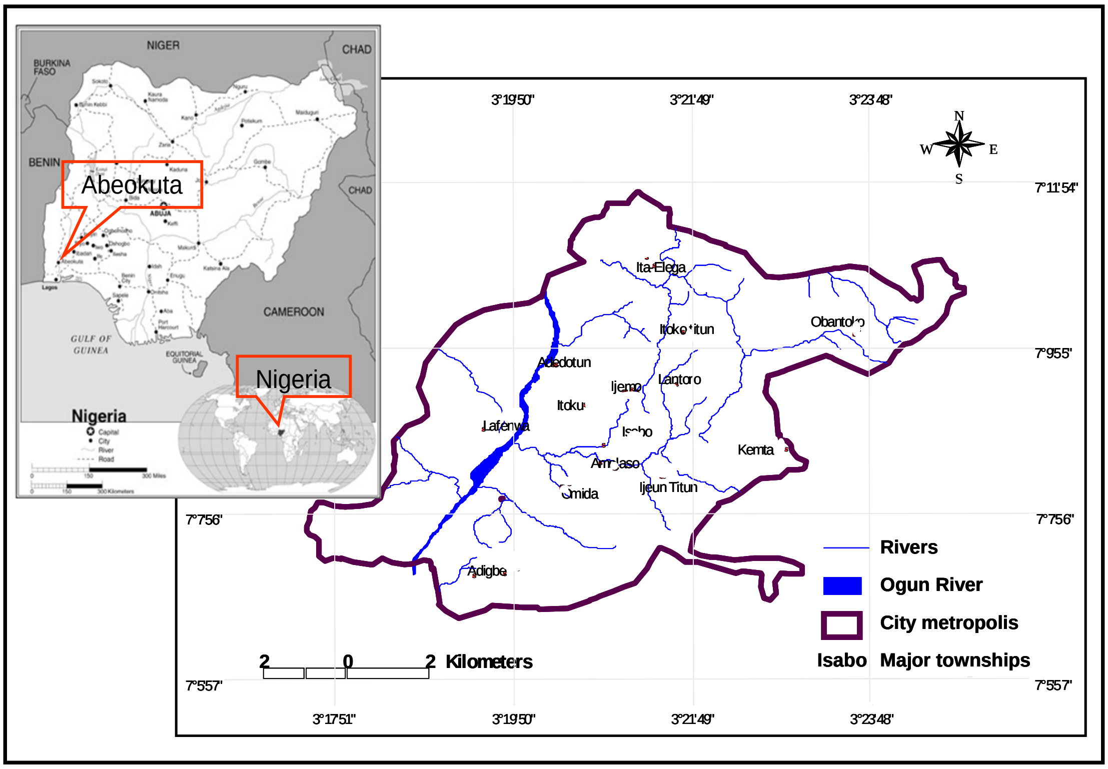
Development of competencies and the adoption of a risk management culture are highlighted as critical prerequisites for risk mitigation and management. The prerequisites stirred a concern and have implications for possible implementation of self supply water safety plans. The research explores the need for competency development in the existing water supply institutional set up in the study area. The research also provides evidence and advocates for the adoption of risk management culture among all the relevant stakeholders.

The ‘yes or no’ scoring system in the available standard sanitary survey forms is rigid. The use of the scoring system either exaggerates or underplays particular risk factors. In this research, the ‘yes or no’ scoring system and the questions in the standard sanitary survey forms are modified to suit the realities of self supply systems.

Lastly, the literature review highlighted the absence of a rapid reading *E-coli* field testing device. Non-availability of this device results in a major limitation in the research.

3 THE RESEARCH AREA

The research area is Abeokuta, a growing city located about 103 km north of Lagos, the former federal capital of Nigeria, and 81 km southwest of Ibadan, capital of Oyo State. Abeokuta serves dual role as the state capital of Ogun State in southwest Nigeria, as well as the Abeokuta Local Government headquarters (Figure 3-1).



Map of Abeokuta, generated through Arc view 3.3

Figure 3-1: Map of the research area, Abeokuta, Nigeria

3.1 Background and Historical Highlights

Abeokuta, a word meaning "under the rocks", dates from 1825, and owes its origin to the inroads of the slave hunters from Dahomey[18] and Ibadan (Ajisafe, 1964).

[18] Dahomey is the present day Republic of Benin

Activities of the slave hunters compelled the village populations scattered over the open country to take refuge in among the rocks surrounding the city. Here they constituted themselves a free confederacy of many distinct groups, each preserving the traditional customs, religious rites and even the very names of their original villages. The original settlers of Abeokuta were of the Egba ethnicity. Notable groups are Egba Alake, Oke-Ona, Gbagura, and Owu (Blair, 1937). The major historical highlights include the operation of the Baptist and Anglican missionaries in the area in the 19th century. The defeat of the slave raiders from Dahomey by the forces of Abeokuta in 1851 and 1864, and in 1893, the Egba United Government based in Abeokuta was recognized by the United Kingdom. In 1914, the city was made part of the colony of Nigeria by the British government (Ajisafe, 1964). The main religious groups are Christianity, Islam, and traditional religious beliefs.

3.2 Demography and Socio-Economic Structures

Based on the 2006 national population survey, the city has 250,278 people inhabiting some 50 heterogeneous townships. Most of the people living within the city are engaged either in public and private employment or large and small scale business activities. The federal, state and local governments provide the formal type of employment. For instance about 89% of the federal government agencies are found within the city while virtually all the state public institutions and major banks in the country are either located or have branch offices in the city (Onakomaiya et al., 1992). The relative position and proximity of Abeokuta to Lagos and Ibadan, makes it accessible to these neighbouring economically developed State capital cities of Lagos and Oyo State respectively.

3.3 Climate

Abeokuta is located in the humid tropics. There are eight months of rainfall from March to October and four months of dry season from November to February (Onakomaiya et al., 1992). The annual rainfall distribution has a bi-modal pattern with the first rainfall peak occurring in June/July while the second peak occurs in September (Figure 3-2). The average annual rainfall is 1,220 mm with an average monthly rainfall of 102 mm. The monthly maximum temperature in the city varies between 29^{o}C during the peak of the wet season and 36^{o}C at the onset of the rainy season (Figure 3-3). The average temperature is 27^{o}C while the minimum temperature varies between 22 and 25^{o}C (Table 3-1).

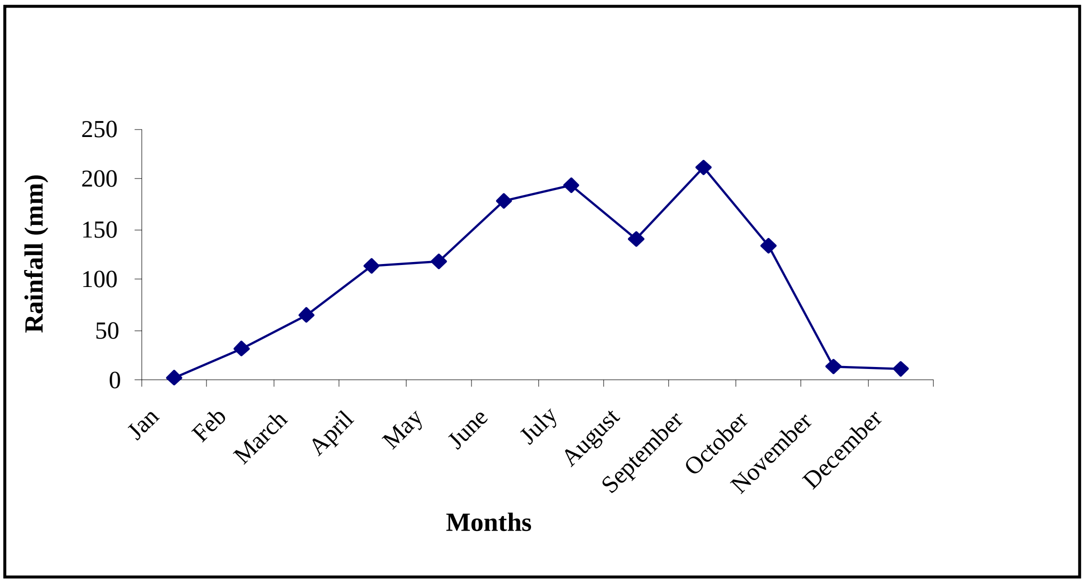
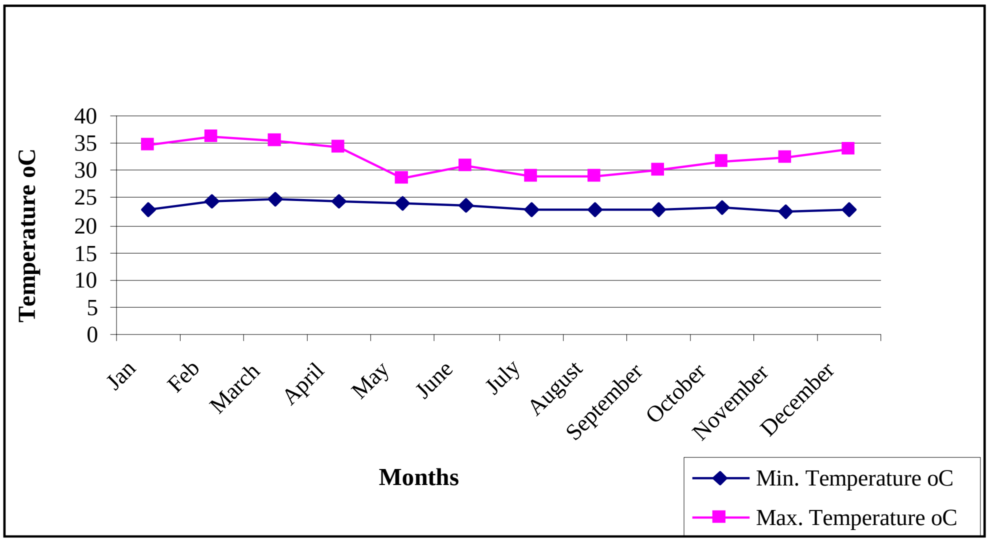


Figure 3-2: Ten years rainfall distribution for Abeokuta (1991-2000), showing bi-modal pattern (Adapted from Federal Ministry of Aviation, Abeokuta, data).



Source: Data (2008) from the Federal Ministry of Aviation, Abeokuta, Nigeria

Figure 3-3: Mean monthly maximum and minimum temperature for Abeokuta, Nigeria.

Table 3-1: Rainfall and temperature characteristics in Abeokuta, Nigeria

Average rainfall (mm)		Monthly temperature (^{o}C)		
Monthly	**Annual**	**Maximum**	**Minimum**	Average
102	1,220	29 - 36	22 - 25	27

3.4 Vegetation and Land Use

Abeokuta is located at an altitude of approximately 157 m above sea level amidst isolated out-crops of natural formation of granitic rocks, which gives the city's landscape its undulating characteristics. There are two major physical features, which have exerted direct influence on the physical growth and development of the city. The first is the presence of Olumo rock (172.8 m) at the central part of the city. The other is the Ogun River located at the South-western part passing through the foot of Ashuwon hill. These physical features produced a unique pattern of landscape for the city and, to some extent, limited the physical growth and expansion of the city to the flatter and more easily developed terrain.

Oyesiku and Kojeku (1992) noted that '*Abeokuta, like most traditional urban centres in Nigeria, has continued to develop amorphously without conscious physical planning. In spite of its long years of existence, the city has no physical development plan (e.g. master plan) as different land uses juxtapose each other*'(Figure 3-4). The noted is largely a reflection of the city's traditional setting before and during the colonial administration.

Figure 3-4: The unplanned city scenery of Abeokuta, Nigeria

Four major land uses are however predominant. The first is the large number of public institutions in the city, notably educational and health institutions. Onakomaiya et al. (1992) opined that the large presence of especially the educational institutions may be associated with Abeokuta being one of the earliest beneficiaries of western education in Nigeria. For instance, there are over 100 free and fee-paying nursery and primary schools, 33 secondary schools, five post secondary institutions including a polytechnic and a federal University of Agriculture. The health sector is made up of eight general hospitals and dental clinics, more than 21 private and public maternity homes, and numerous dispensaries. Alternative medicine is also provided by the traditional medical practitioners, who still enjoy substantial patronage.

The major modern commercial activities are concentrated around the traditional nuclei of the city and hence form the second main land use feature of the city. Abeokuta is the commercial nerve centre of Ogun State where traders and business men from all parts of the State and country meet to transact business. Commercial activities are carried out mainly in the traditional markets and frontage retail shops in residential areas. There are 14 traditional markets, most of which are daily markets including the ultra modern King Lipede market.

There are presently few large scale industrial establishments. However medium and small scale plants engaged in sawmilling, food processing, clothing, woodworks, carving, quarrying, pottery, confectionery, steel works and dyeing are numerous in the city. The tie and dye cottage industry is particularly famous and peculiar to Abeokuta. The Itoku traditional tie and dye market also serve as one of the tourist attraction in the city. The influence of the numerous cottage industries on the land use pattern is therefore sizable.

The fourth land use is the densely populated residential area. This land use pattern is facilitated by the transformation of Abeokuta into a centre of political, economic and administrative activities.

3.5 Hydrogeology

The city stands on crystalline Basement and is overlooked by flat-topped hills consisting of deeply dissected outliers of Cretaceous rocks, which reach an elevation of over 183 m. Despite the steepness of the hillsides, the sedimentary rocks are not well exposed but a number of outcrops of coarse, ill sorted, clayey, brown sandstone occur about 61 m above the base of the succession. Outcrops of cross-bedded, ferruginous sandstones and pebbly sandstones have been noted however near the base of the succession among the outliers southeast of Abeokuta (Jones and Hockey, 1964).

In Basement Complex areas, the major components of flow are along the base of the weathered zone because the weathered aquifer is connected to the fractured fresh rock aquifer (Wright and Burgess, 1992). Usually the weathered zone of basement areas is complex and variable due to lithology, weathering history, mineralogy, and hydraulic properties of the weathered aquifer to mention a few. Where rainfall is high - as in the case of Abeokuta - most of the water movement is horizontal in the brecciated top of the cohesive weathered bedrock lying just above the fresh bedrock. Martins et al. (2000) agreed that the groundwater occurrence in Abeokuta is limited to the fractured and in-situ weathered portion of the rocks. Consequently, groundwater supply through hand dug wells varies in depth, and exploitation of the resource is limited to the weathered portion.

3.6 Water Supply Practices

Government water supply – tap water- is distributed nearly into every area of the city, with the exception of newly developed areas of the city. Households living in the Government Residential Areas (GRA) of the city are allowed only the public supply and nothing else. That is they are not allowed to construct a well or borehole. The supply of tap water to the GRA is on an average of once per week and this distribution is fairly consistent. During the dry season however, it reduces to once in 2 weeks. To cater for the shortfalls, the strategy of the users is to procure big storage tanks, usually plastic surface tanks and drums to store water for use until the next time the tap water is released.

Other areas of the city are not so lucky in terms of public water distribution and availability. The distribution pattern should also be at least once per week, but the pattern is very erratic. The households that desired and were able to, got connected to the mains but they also depend on other water sources; particularly self supply hand dug wells and/or boreholes. The common practice is that property owners provide a hand dug well on their properties. Where households find the quality of hand dug well water questionable, water for drinking is sourced from boreholes, tap water or bottled and/or sachet water. Generally, rainwater harvesting and the use of streams as a water source are almost completely absent (Oluwasanya, 2004).

4 RESEARCH METHODS

4.1 Background and Evolution of Aims and Methods

The WHO in Davison et al. (2005) highlighted a ten step process for the development of WSP (5.1). The 10 steps formed the primary guide for the method adopted in this research. Noting that the WSP has been developed from studies involving and for big water supply utilities and small community systems, the research started out with the sole aim of adapting the existing WSP procedures to self supply systems to develop a generic WSP for such systems. It is expected that, if well followed, the water safety procedures will ensure safe water delivery from self supply systems.

The characteristics of the management practices surrounding self supply systems as seen in the field however generated questions about the appropriateness or relevance of WSP to self supply systems. The characteristics made it important to know whether WSP can help make self supply systems deliver safe water. It is imperative that pursuing a research on the relevance of WSP to self supply systems should lead to the development of a water safety framework that would be better suited to self supply sources. Consequently the ten steps water safety plans processes were summarised into four main procedures from which the research objectives (1.6) were derived (Figure 4-1).

Five research objectives were formulated from the four water safety planning components in Figure 4-1. The four components are systems assessments, operational monitoring, management and communication, and institutional framework. The sixth objective addresses the recommendation of appropriate water safety plans guidance. From the objectives the course of the research is pulled in two dimensions. For instance, the first of the relevant four steps is systems assessment (Figure 4-1). A part of systems assessment involves hazards identification. An important means of identifying hazards in systems is through water quality testing. Water quality determination is a quantitative measure requiring quantitative data collection. The second research dimension required to capture the practices, operations, management and institutional aspects of self supply systems follows a qualitative method. Subsequently, the research data are composed of both quantitative and qualitative data (Table 4-1).

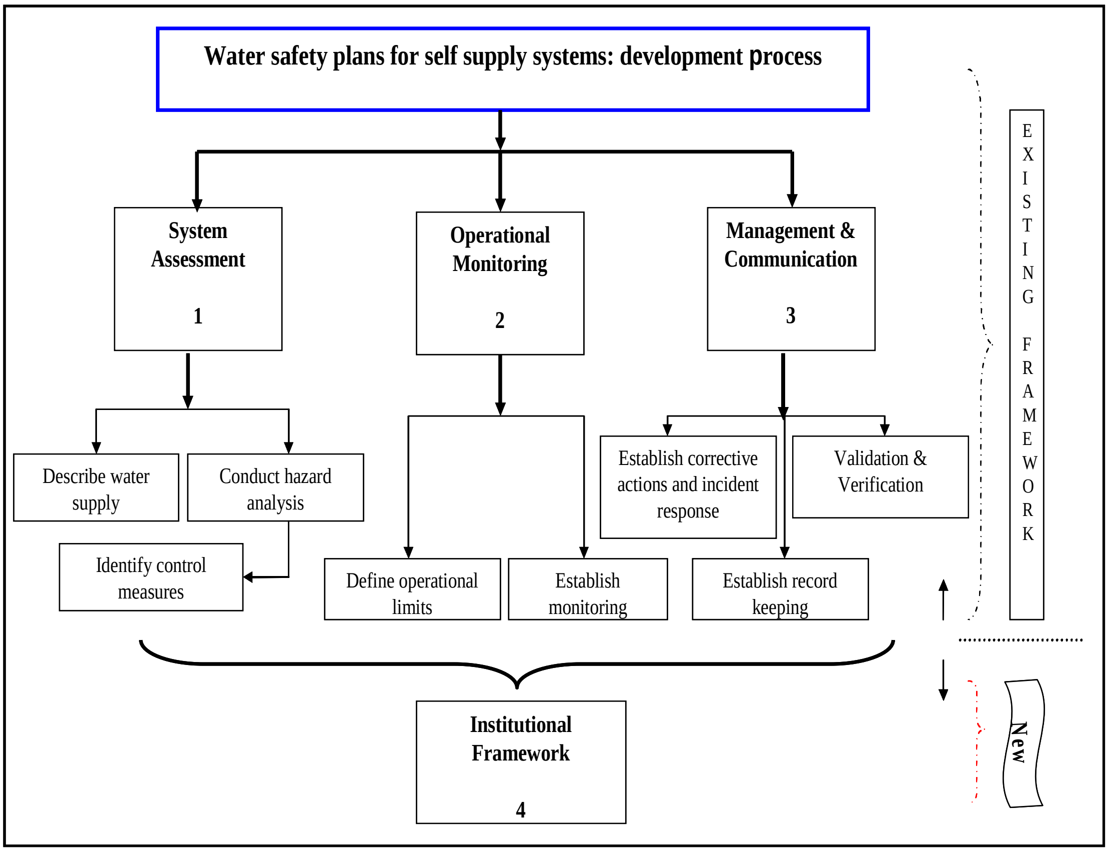


Figure 4-1: Development process of water safety plans for self supply systems

Table 4-1: Formulation of research objectives: summary of aims, objectives and methods

Dates	Aims	Objectives	Methodology
October 2006 to February 2007 *5 months*	Understand water safety plans concept and processes	*Identify steps in water safety plans processes, which are relevant or not to self supply systems *Design methods for field work	Preliminary literature review Detailing and review of researcher's knowledge of research area and self supply systems in the area Development of semi-structured interview questions Adaptation of sanitary survey forms
March 2007 *1 month*	Establish the types of self supply systems in the study area	*Identify the types of self supply sources *Enumerate identified self supply systems	Initial inventory and mapping of self supply systems and locations
April to July 2007 *4 months*	Assess the predominant self supply system in the research area	*Identify systems hazards *Identify possible hazard causes and determine the influence of factors like rainfall and land use on identified hazards *Describe the predominant self supply systems	Water quality determination Sanitary surveys Rainfall data collection Initial semi-structured interviews
August 2007; January to June 2008 *6 months*	Make sense of field data	*Extract from interviews water user perceptions *Model data to generate improved conceptual framework and methodology *Identify data gaps	Correlation and regression analysis of quantitative data Systems risks assessment Literature review for appraisal of interview styles and redesign of semi-structured interview to incorporate open ended questions and testing of identified systems control measures
July to August 2008 *2 months*	Identify systems management, and institutional framework	*Describe systems management *Understand and describe water supply institutional set up	Semi-structured interviews with open ended questions More water quality determination and sanitary survey to validate initial field data
September 2008 to October 2009 *12 months*	Update and improve understanding of self supply systems and the process of water safety planning	*Extract from interviews the management and operation practices, knowledge levels, and factors influencing users' perception and attitude to water safety, and water supply institutional arrangement *Develop conceptual structure for presentation of findings	Data analysis – coding, understanding and description Thesis write up

4.2 Overview of Research Methods

The research methods and subsequent activities are driven by the question 'what do you need to know about self supply systems to examine the relevance of the water safety plan framework to such systems?' Three core knowledge areas are identified, namely self supply systems, water quality of the systems, and the sources of risk to the systems (Figure 4-2). Identification of the core knowledge areas facilitated the identification of the necessary activities. Water quality status is derived from water quality determination; knowledge of the source of risk is generated through sanitary survey and direct observation of the systems operations and management practices, while systems inventory and interviews provided the required knowledge of the systems.

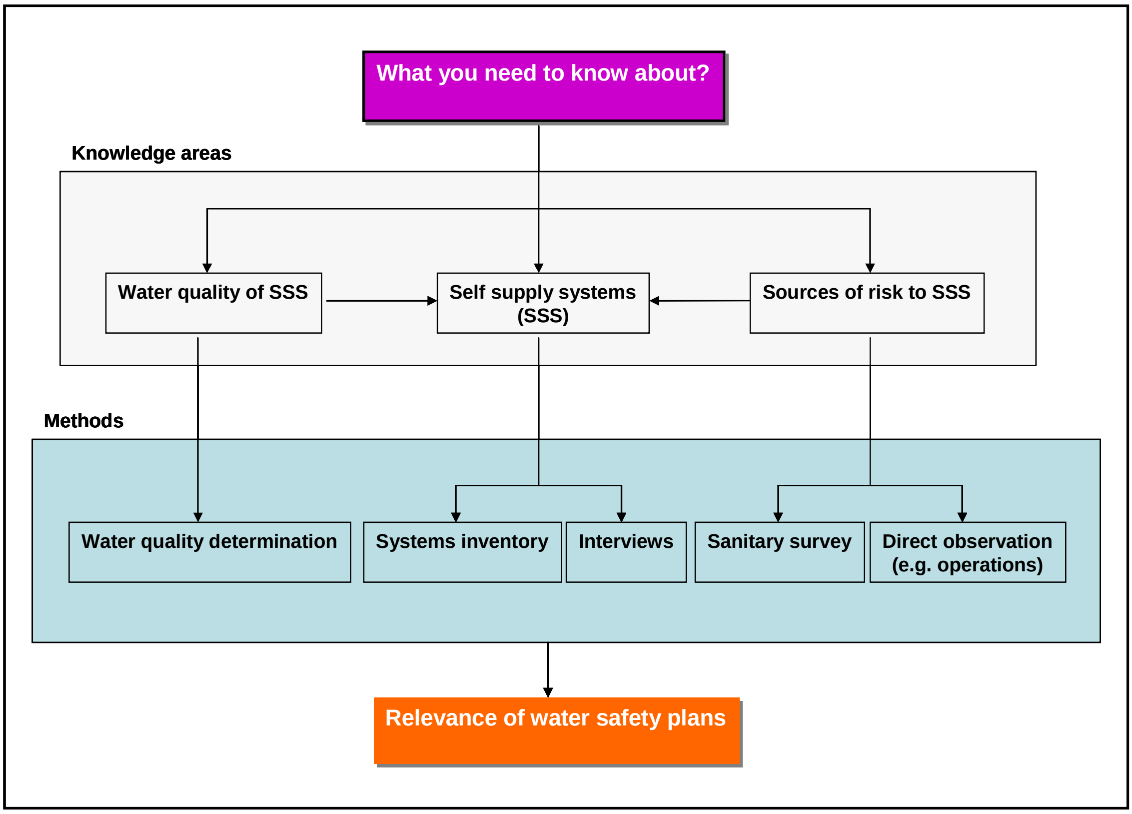


Figure 4-2: Schematic overview of the research methods

4.3 Methodology

The research strategy is basically a descriptive case study. Generally, case studies are a preferred research strategy when 'how' or 'why' questions are posed, when the investigator has little control over events, and when the focus is on a contemporary phenomenon within some real life context (Stake, 1978; Yin, 2003; Yin, 2009). This research qualifies as a case study as it studies the relevance of water safety plans to self supply systems in one city. The researcher has little control over events and the focus (water safety plans) is a contemporary phenomenon within the context of urban self supply systems. The conduct of the research is devoid of experimental manipulations in which behaviour or practices are manipulated directly or systematically hence the reference to little control of events. Other features that qualify this research as a case study are direct and first hand observation of events under study and interviews of the persons involved in the events of self supply systems practices. The research is thus able to deal with a variety of evidence – measurements, literature, interviews and observations.

4.3.1 Theoretical aspects

The technical definition of a case study begins with the scope of the study. Yin (2003) defines a case study '*as an empirical inquiry that investigates a contemporary phenomenon within its real life context, especially when the boundaries between phenomenon and context are not clearly evident*'. Yin's definition is important to the uniqueness of a case study, as the phenomenon of study is linked closely with its context. The definition particularly distinguishes a case study from experimental studies in which the focus of study is often divorced or isolated from its context. The contextual conditions for self supply systems are therefore highly pertinent. The context also particularly differentiates this research from public or community water supply systems scenarios.

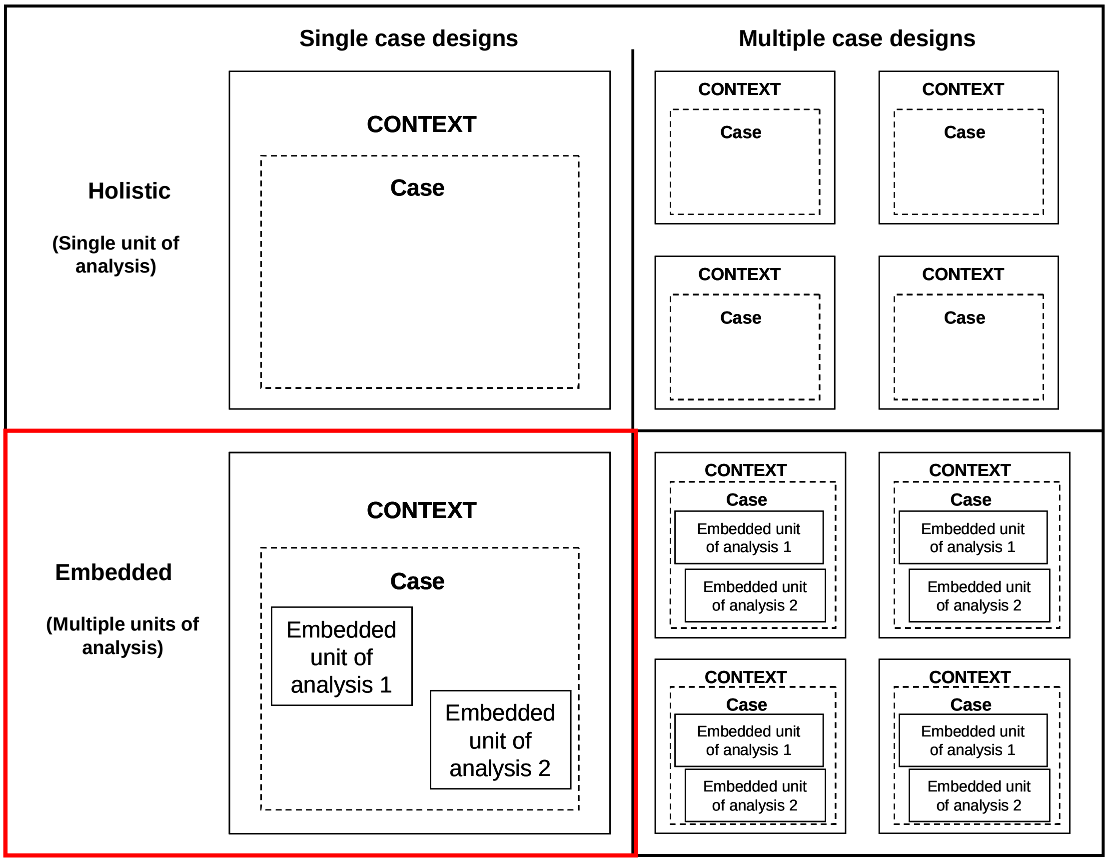
Another important definition of a case study is given by Stoecker (1991). '*The case study inquiry copes with the technical distinctive situation in which there will be many* *variables of interest than data points, and as one result relies on multiple sources of evidence, with data needing to converge in a triangulating fashion, and as another result benefits from the prior development of theoretical propositions to guide data collection and analysis*'. Stoecker's definition portrays a case study as a comprehensive research strategy and not a mere design feature or a data collection approach. The definition also noted '*…the benefits of prior development of theoretical propositions to guide data collection and analysis*'. The data collection and analytical procedures followed in this research are primarily guided and built on the existing WHO water safety plans propositions.

As a method, a number of variations exist within case studies. Three variations are highlighted. There are single or multiple case studies (Agranoff and Radin, 1991; Dion, 1998) and case studies based on a mix of quantitative and qualitative evidences (Yin, 1994; Verschuren and Doorewaard, 1999). Case studies are conducted and written with the motive to arrive at broad generalisations based on case study evidence (Stake, 1978; Yin, 2003). In the first instance, this research is categorised as a single case study to the extent that the research studied only self supply systems, only hand dug wells as a type of self supply system in only Abeokuta, Nigeria. Secondly the research collects a mix of both qualitative and quantitative data. The latter issue of generalization is however debatable.

There is a common concern that case studies provide little basis for scientific generalisation. However the same concern can be extended to experimental research methods. The query 'how can you generalise from a single case' can also be asked in experimental design 'how can you generalise from a single experiment?' Equally that scientific facts are based on multiple set of experiments that have replicated the same phenomenon under different conditions is arguably applicable in case studies. The same approach can be used in multiple case studies but with different concept of appropriate research designs. In any case, Yin (2003) concludes that case studies, like experiments, are generalizable to theoretical propositions. The case study, like experiment, does not represent a 'sample', and the goal of case study is to expound and generalise theories (analytical generalisation) and not to enumerate frequencies (statistical generalisation). In this research, statistical generalisation is avoided as much as possible but the concept of water safety plans and risk management is broadly expanded and generalised within the context of self supply systems.

4.3.2 Research designs

The research is designed to fit the embedded single case study theory in which self supply systems forms the unit of analysis or the case (Yin, 2003; Yin, 2009). Self supply hand dug wells are the embedded units of analysis within the identified case study (Figure 4-3). The selection of the investigated hand dug wells was made through suitable sampling techniques (4.4.3; 4.4.5).

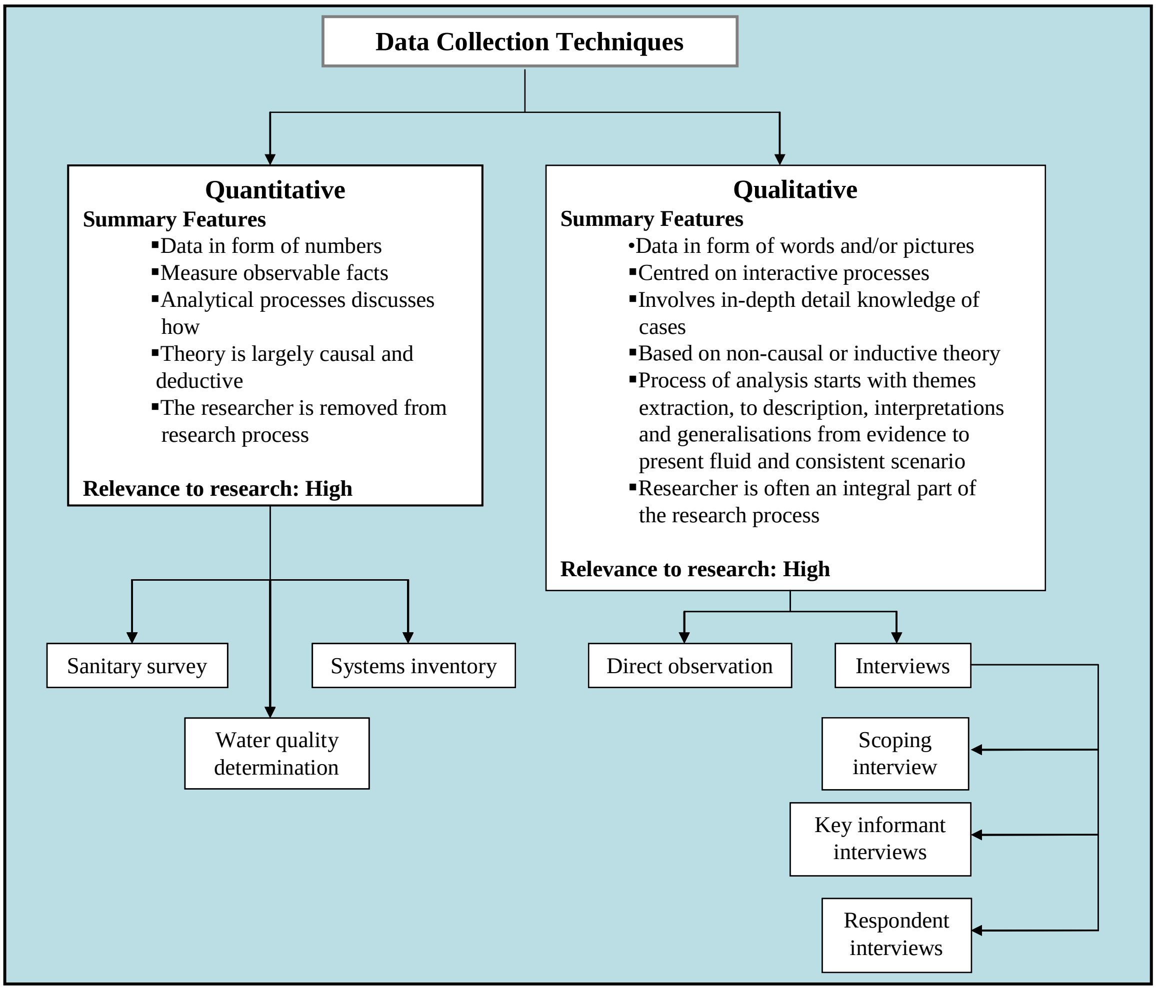


Source: COSMOS Corporation; In Yin (2009); The research design fits the highlighted design

Figure 4-3 Basic types of designs for case studies

4.3.3 Quantitative and qualitative data collection methods

There are many data collection techniques. The available techniques are however grouped into two broad categories: quantitative and qualitative. The main distinction between the two categories is that quantitative involves collection of data in form of numbers while qualitative collects data in the form of words and pictures (Neuman, 2003). A summary of the other characteristic features of the broad data collection categories are presented in Figure 4-4. Figure 4-4 also highlights the various data collection approaches used in this research under the identified categories, and indicates the relevance of each category to the research.



(Adapted from Neuman, 2003)

Figure 4-4: Summary of the research data collection techniques

4.3.4 Field visits

The research field data was scheduled and collected within two field visits. The initial field visit covered a period of 5 months between March and July 2007. The visit was scheduled to coincide with the onset of rainy season in the study area to capture as much as possible the influence (if any) of rainfall events on the water quality of self supply wells. The first field study was aimed primarily for the quantitative data collection. This aspect of the research involved the water quality determination, sanitary surveys, and observation of water systems practices. Repeat water sampling and survey was required to ensure validity for the water quality testing and sanitary inspections. Four repeat visits were made between April and July 2007 on a frequency of once per month. To optimize the opportunity of repeat visits to wells, owners and users of the selected wells were engaged in conversational but semi-structured open ended discussions on each visit. Interview questions varied from water uses, systems operation, and management, to perceptions of health impact, and water safety. The second field study was shorter in duration; a period of 6 weeks between July and August 2008. The second visit was primarily scheduled for the qualitative research data aspect.

4.4 Selection Processes

4.4.1 Selection of research area

Abeokuta was selected based on:

- Accessibility to groundwater resources via boreholes and hand dug wells
- The existence and use of self supply wells
- The large number of households using self supply wells
- Self supply systems have been in practice for a long time[19]
- The usage of water
- Researcher’s knowledge of the area

[19] A minimum of one year was used to establish the real impact of use on health

For about 20 years, the author schooled and worked in Abeokuta. The author was also involved in two previous water management-related academic research projects in the city.

4.4.2 Cluster selection

Self supply systems are widely spread throughout households across the numerous heterogeneous townships in the study area. A cluster–based approach proposed in Howard (2003) was adapted to select townships and consequently the number of self supply wells within the area. The approach required the identification of factors that will form the basis of selection. To facilitate the choice of criteria for township selection, the author made an assumption that population density, degree of town planning and land use had significant influence on self supply water quality. The variants in the assumptions were subsequently used as factors (criteria) of identification to isolate homogenous townships. Four land use areas were selected. They included:

1. Residential
2. Commercial or trading (market) areas
3. Locations with public institutional establishment like hospitals, and
4. (Cottage) industrial areas.

The four land use areas are the predominant land use patterns in the study area (see section 3.4). The isolated townships are then grouped into clusters (Annex 1 - Table A1).

Eleven clusters emerged. To further identify the clusters to prioritise for the research, a five by four matrix chart was constructed based on the four land use areas on a range (1 – 5) of the degree of town planning and population density. Specifically the degree of town planning and population density varied from planned to unplanned, and low to high respectively (Annex 1 - Table A2). The eleven clusters were fitted to approximate location on the matrix. Again using the assumption that the factors of township identification had significant influence on self supply water quality, five priority clusters were selected (Figure 4-5). The five clusters represent four priority clusters plus one cluster to serve as control. The clusters were:

1. High population density/residential
2. High population density/commercial
3. High population density/institutional
4. High population density/industrial
5. Low population density/residential (control)

It should be noted that the study area is generally unplanned. Using the priority clusters as a guide, townships were listed and five[20] wells were allocated to each town for visitation (Annex 1 – Table A3). The five wells per town was obtained by taking a transect walk through each town and selecting the first five wells. Where the number of wells was not up to five, the available wells were selected.

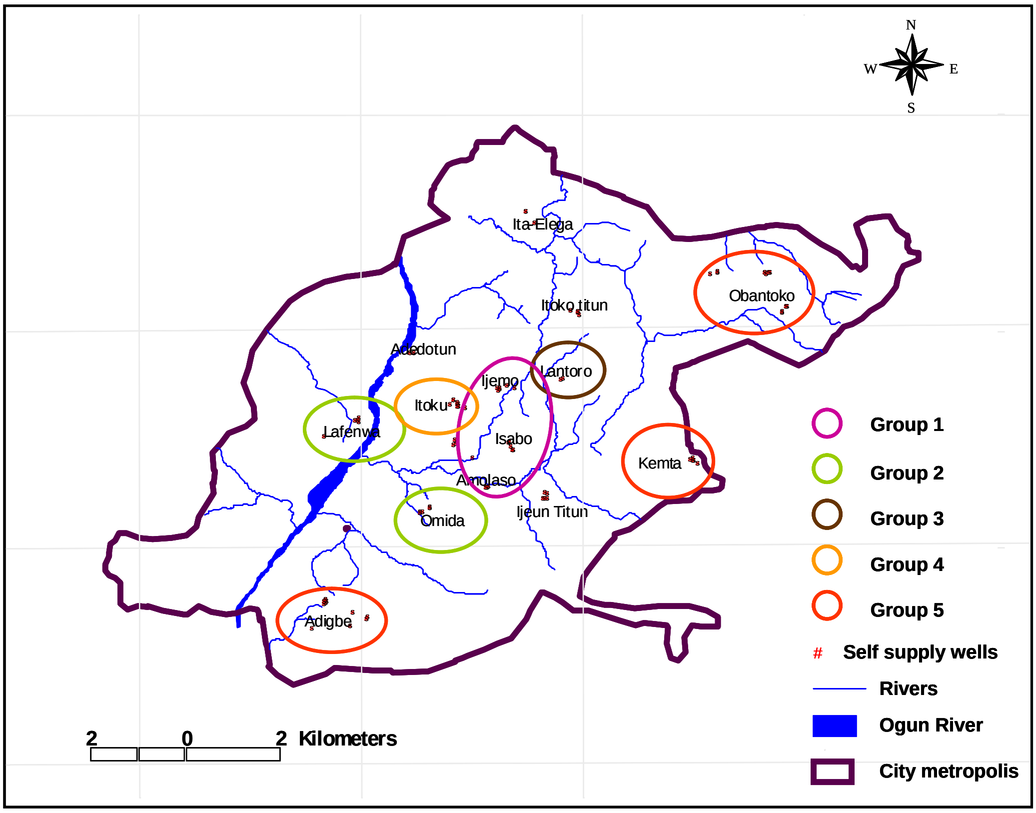


Figure 4-5: Map of Abeokuta showing priority cluster group areas

[20] The choice of number is subjective and not statistically representative. A maximum of about 100 water samples could be allowed within the available research budget

4.4.3 Well selection process I

A total of 82 wells were visited, out of which 25 wells were selected. Since the phenomenon of study is water safety, the self supply wells with the most critical sanitary conditions and microbial water quality status within each cluster were primarily selected (Annex 2 – Table A4). Wells with critical sanitary conditions were identified through another round of priority matrix this time using the sanitary inspection scores (4.5.3) and microbial concentrations (4.5.2). Two sets of sanitary inspection scores were used for selection. The first set of scores were sum of scores over the maximum possible score across a 1 – 5 scoring scale from 17 questions. The second set of scores were sum of scores over the maximum possible score across a 1-5 scoring scale from eight more focused questions (4.5.3).

Other criteria that were used in the selection of the 25 wells include uses of water, availability of alternative water sources, and owners/users reception of the research.

4.4.4 Method iterations

It was necessary to adapt to the field realities as they emerged. The sanitary inspection procedures (4.5.3) especially qualify in this respect. Aside modifications to the sanitary inspection procedures, which occurred in the field, review of the first field work also identified gaps, which forced changes to be made in the research approaches used for the second field study.

Irregularities were identified in the measurements of the microbiological parameters (4.5.2) in the first field work. The microbial parameters that were investigated were the total coliform, *E. coli* and c*lostridium perfringens* (4.5.2). The total coliform count was good and consistent. Consistency is in terms of having complete data set; four sets of results for each of the key selected wells. The same claim however could not be made with regards to *E. coli* results. Some of the results were out right missing and some results were given as simply ‘present’ without numerical values. Missing results made data difficult to analyse and interpret. The reasons provided by the consulting laboratory for the inconsistency were logistics (inability to procure *E. coli* agar/media for the first set of sampling), technical hitches, high turbidity, and high level of coliform contamination in some of the water samples. Relying on the external local laboratory for microbial measurements thus represented a major limitation in the research (4.8).

To address the identified gap, repeating *E. coli* testing in the second field work was not considered feasible. *Escherichia coli* testing is time consuming and the time for the second field trip was limited. As a result, nitrate-NO_3 and chloride testing were considered based on recommendation of Schmoll et al. (2006) to serve as contamination markers for the hand dug wells.

Given by Schmoll et al. (2006), nitrate-NO_3 is frequently used as an indicator of sewage input, as it is derived from the microbial oxidation of excreted ammonia in soils, and is generally conserved in groundwater. The ratio of nitrate-NO_3 to chloride is however regarded as a more reliable tool. Although the precise ratio depends on population density and leaching to groundwater, high value of the ratios is indicative of contamination of faecal origin (Morris et al., 1994). A major draw back is that nitrate-NO_3 to chloride ratio varies with season, particularly in shallow wells (Morris et al., 1994). However, the purpose of using nitrate-NO_3 and chloride testing in the research is primarily to check the water quality status of shallow wells in the study area. Usage of the ratio was to be limited to indicate microbial pollution, especially contamination of faecal origin, and not necessarily focused on seasonal variation of the ratio.

The other inherent advantages of using nitrate-NO_3 and chloride as microbial indicator parameters in the research included:

- Ease of measurement
- Cheaper cost and analysis
- Ease of logistics
- Makes more numerical sense - that is more water samples can be measured.

However, to get a complete overview of self supply wells water quality status in the study area, and for the purpose of getting better analytical comparison, repeat testing of the previously measured non-microbial parameters namely: water temperature, pH, turbidity and electrical conductivity was proposed and included in the second field activities. Chloride testing was however eventually dropped due to non-availability of chloride testing kit at the time of the second field trip.

Another question was raised on the proposed water quality analysis. How many times should measurements be taken within the available field work period? A one-off will imply results from a wide range of wells from across the study area, with a possibility of allowing comparison between the previously selected five clusters (4.4.2). Weekly or bi-weekly measurements may serve to compare results of same wells over a 6 week period and possibly comparing the results with rainfall data. However, the possibility of rains within the second field period was slim. After careful consideration of possible options, a bi-weekly water quality testing was adopted. Taking the average of three data sets was also expected to have better statistical value than a one-off or two data sets.

Four tentative hand-dug well selection criteria were proposed in the consideration of the selection criteria and the number of wells that would be representative for the purpose of the research. They are outlined in Box 4-1 (A – D). The merits and limitations of each option were considered, after which option D emerged as the most probable and time effective choice (Annex 2 – Box A1). In option D, three wells were proposed for selection in each of the five research clusters. The eventual well selection was based on two major factors, namely the level of well protection[21] and access. Well protection is described in terms of protected, semi-protected or un-protected (Figure 4-6).

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[21] Level of well protection incorporates quality of construction and generally indicates the level of management

Three types of access are noted; restricted (strictly by permission from source owners) access, monitored (owner supervised access) or free access. Consequently any three selected wells within each of the five research clusters fell into the classification criteria as follows:

- Class 1 or Good: Protected well/monitored to restricted access
- Class 2 or Fair: Semi-protected/monitored to free access
- Class 3 or Poor: Un-protected/free access

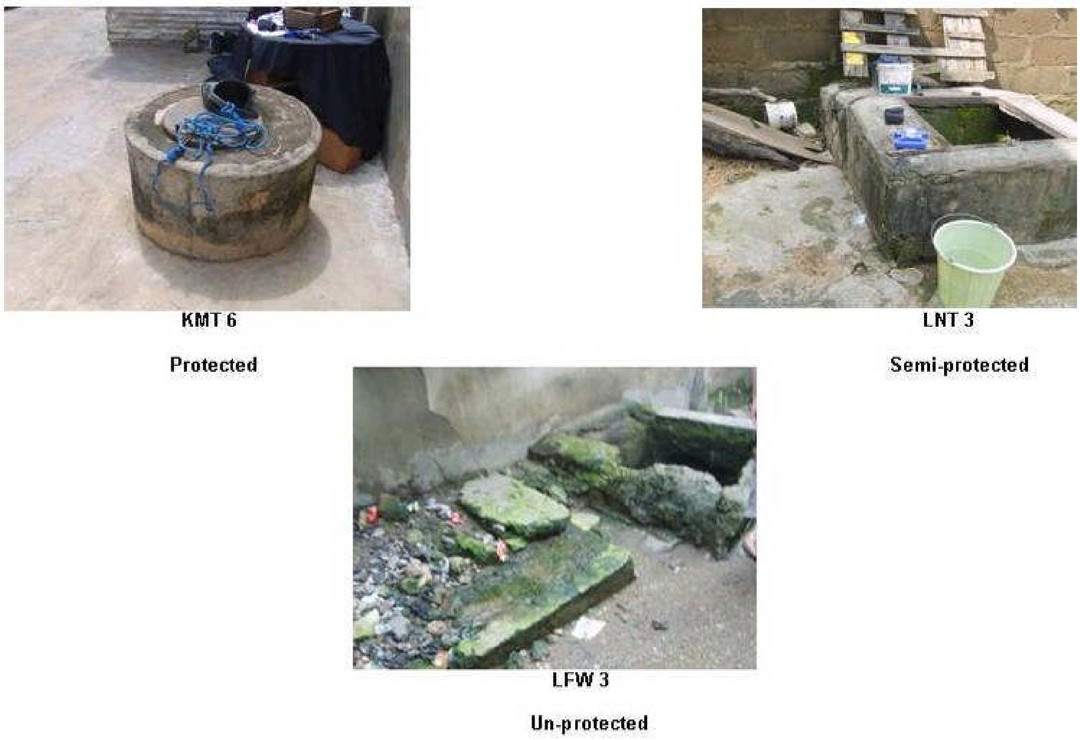


Figure 4-6: Examples of well protection within self supply hand dug wells

Presentation of the proposed hand-dug well selection criteria options A, B, C and D

Option A:

1. Protected well with pump/owner managed or resident owner (P^+)
2. Protected well with dedicated bucket & rope/owner managed (P^-)
3. Protected well; with lining, cover, pump/absent owner (P^-)
4. Semi-protected well +/- owner managed (S)
5. Unprotected well; no lining, no cover, free access, absent owner, not managed (U)

Option A is based on well classifications derived from first field work data (Table 3-a). The classifications in option A are subjective but the descriptions represented the various forms of practices identified with hand dug wells sampled in the first field work.

Option B:

1. Protected with pump/dedicated bucket & rope + owner managed
2. Protected with pump or dedicated bucket & rope – owner managed
3. Protected without dedicated bucket & rope +/- owner managed
4. Semi-protected wells +/- owner managed
5. Unprotected wells; no lining, no cover, free access, absent owner, not managed

Option B tries to simplify the wells classified as P^+ and P^- in option A.

Option C:

1. Protected well with pump/owner managed or resident owner (P^+) (1)
2. Protected well with dedicated bucket & rope/owner managed (P^{-1}) (2)
3. Protected well; with lining, cover, no dedicated bucket/absent owner (P^{-2}) (4)
4. Semi-protected well +/- owner managed (S) (11)
5. Unprotected well; no lining, no cover, free access, absent owner, not managed (U) (7)

NB: (1) Indicated the number of wells in the 1st field work that fits into each classification.

In option C, the numbers of wells in the first field work that fits into each well category was inserted in an attempt to judge the importance of each of the well category in the study area.

Option D:
Due to time constraints, a lower number of observation wells were recommended. Consequently, the selection criteria were reviewed from a five-point to a three-point criterion, but selection points remained the five research clusters. The original well classification/categories were thus modified to include type of access as follows:
Class 1/Good: - Protected well/monitored to restricted access
Class 2/Fair: - Semi-protected/monitored to free access
Class 3/Poor: - Un-protected/free access

It is expected that selection of the new categories of wells from same or previously selected clusters would allow for comparison in the research data analysis (Annex D).
Table 4-a: Hand dug well classifications based on structure and mode of operation

	Hand dug well structures*				
Well operations	**LCAD**	**LAD**	**CAD**	**LC**	**None**
Pump	P^+	S	S	P^-	U
Bucket/Rope	P^-	S	S	S	U

* Based on existing practices; L: Lining; C: Cover; A: Apron; D: Drainage; P: Protected well; +: best practice; - Lower level than best practise; S: Semi-protected or missing one or more construction features; U: Unprotected or missing most of/no protective feature

Box 4-1: Methods iterations – well selection processes

4.4.5 Well selection process II

Consequent to the need for change, in the second field work hand dug well selection was based on a three-point criterion hinged on level of protection and type of access allowed (Box 4-1). A purposive snowballing sampling method (Robson, 2002) was used to identify wells within the research clusters. Where the sampling method was not feasible, randomised sampling through a transect walk within the cluster townships was used. In all, 16 wells were selected for sampling. The number represented three wells from four of the five research clusters, and four wells from research cluster 5, the control cluster. Consequently repeat sampling and sanitary surveys were conducted in a total of 41 (25 wells in the first and 16 wells in the second field study) wells during the course of the research.

4.5 Quantitative Data Collection Activities and Methods

The data collection approaches relating to quantitative measures in the research are described in this section.

4.5.1 Systems inventory

To generate maps (Figure 3-1; Figure 7-2) for the study, obtain the inventory and investigate likely sources of contaminations, self supply sources and toilets in Abeokuta were located (house-to-house) and geo-referenced with the aid of a geographical positioning system tool – Garmin GPS 12 (Serial number 36306200)**.** The distances of available toilets to wells were also measured with a measuring tape.

4.5.2 Determination of water quality parameters

Samples for microbial analysis were taken from hand-dug wells in sterile bottles, stored and transported in a cool box kept below 4^{o}C. Analysis of E. coli and *clostridium perfringens* were performed within 6h of sampling by staff at the Nigeria Institute of Medical Research (NIMR), Lagos, Nigeria. Laboratory (not field) analysis of the microbial parameters was necessary because an incubation period of at least 24h is required per sample of water, the volume of water samples was high (100 samples), and there was limited research personnel (one researcher and one field assistant) in a multi-task (in-situ water analysis, sanitary survey, and/or interviews) fixed period field study.

The indicator bacteria for microbial analysis were faecal coliform (*E. coli)* and c*lostridium perfringens*. Isolation and enumeration of total coliforms and *E. coli* was done by using the multiple tube/most probable numbers technique. One in 100 dilutions of the samples were prepared, portioned in bottles containing Durham's (Cheesbrough, 2005) tubes and cultured in McConkey (Cheesbrough, 2005) broth. The inoculated broths were incubated in a water bath at 44^{o}C for 24 hours with the bottles loosely capped. Bottles which showed a change of colour from purple to yellow, and gas production by the collection of bubbles were counted. The most probable number was obtained from McCrady's statistical table (Annex 3). A sample showing positive colonies was further subjected to an Eijkman test[22] to identify the isolates.

Clostridium perfringens were isolated by gram staining colonies, which were plated out on Mueller Hinton and Blood agar. The gram positive bacilli were then sub-cultured unto Blood agar and incubated in 10% carbon IV oxide at 37^{o}C for 48 hours. *Clostridium* spores were identified as colonies showing beta-haemolysis. The presence of clostridium in groundwater suggested that the source may be liable to intermittent contamination. Clostridium may also be detected long after and far from pollution event because it can survive for extended period of time by producing spores.

[22] Eijkman test involves incubating inoculated glucose-peptone broth at 46^{o}C. Gas formation is said to indicate the presence of *E. coli*

The physiochemical analysis of water samples was done in situ. Five non-microbial parameters were investigated; they were pH, temperature, turbidity, electrical conductivity, and nitrates-NO_3 concentrations. Similar methods of water quality determination were applied in the two rounds of study for the parameters except for turbidity. Turbidity was measured in Jackson Turbidity Units (JTU) using the standard dual-cylinder[23] kit in the first round of study and in FTU from a HACH DR/2000 direct reading spectrophotometer in the second field trip. Water temperature (^{o}C), conductivity (Micro-semen/cm) and pH were measured with the aid of a portable meter – HANNA H1991301. The meter calibration was based on the FWPCA methods for chemical analysis of water and wastes (USD, 1971). Nitrate-NO_3 values were measured in mg/l with the aid of a Merckoquant nitrat-test strips in a nitrate meter – Nitrachek 404. The nitrate meter was calibrated based on the manufacturer's (C-TECH Electronics Limited) instruction manual. The nitrate meter applies colorimetric method. Other materials used were sterilizing spirit, bucket and rope to draw well water.

4.5.3 Sanitary inspections

At each well a sanitary survey was performed when the sample was taken. Generally, sanitary inspections were a function of recording or scoring observed sanitary conditions. Observations are scored and recorded in unified formats for easy assessments. A number of standard forms have been developed for different types of water sources but none particularly for self supply systems. For the research, a sanitary inspection format adapted from Godfrey and Howard (2005) and Lloyd and Helmer (1990) was modified for self supply systems. The modified format was however revised to accommodate actual self supply realities experienced in the field.

[23] A dual-cylinder kit compares the visibility of a given pattern (black dot on a white background) with a 'turbidity' standard. The measurement reflects the amount of standard solution added to match the sample's transparency.

The first modified form (SI 1) drafted 17 questions from Godfrey and Howard (2005) and Lloyd and Helmer (1990) sanitary inspection forms with some of the questions rephrased (Annex 4 – A4.1). The scoring system was also changed from a two-way yes or no answer to a scoring scale of 1 - 5 (Annex 4 – A4.1) such that each question is weighted 1 – 5. One being the worst score (poor sanitary condition). Therefore the scores across all the wells could range from 17 (worst possible) to 85 (best possible).

During the first field visit, the SI 1 form was revised (SI 2) to contain eight questions[24], 1 – 5 scoring scale, and criteria for scoring each question (Annex 4 – A4.2). With SI 2, the scores across the wells ranged from eight (worst possible) to 40 (best possible). The revision was necessary because most of the 17 questions in SI 1 were found to be irrelevant to self supply sources. For instance question 14 on the SI 1 form '*Is the dedicated pump loose at the point of attachment to the well…*?' is generally not applicable as the common mode of self supply well operation is through a drawing bucket (Annex 4 – A4.1). Consequently many questions could not be scored for most of the observed wells as the intended sanitary fault did not exist.

The SI 2 format was tested again in the second field work of the research. The result of the sanitary scores derived from SI 2 reflected the observed sanitary conditions of wells better than the scores derived from SI 1. The judgement of 'better' is however subjective.

4.6 Qualitative Data Collection Methods

The purpose of the qualitative aspect is to assess owners/users' perceptions of water quality, source and water safety, and safety interventions. Qualitative data are also necessary to understand self supply systems practices – operations and management. Robson (2002) advised '*To find out what people do in public use direct*

[24] Represented the 8 most relevant questions to self supply systems in the study area; they included questions on toilets, burial sites, solid waste dumps, source protection and operation

observation…what they think, feel and/or believe, use interviews, questionnaires or attitude scales..'. This rule of thumb was applied.

4.6.1 Direct observations

Direct observation was employed to capture the sanitary state of self supply systems, operations, maintenance and various forms of activities surrounding management practices and water use. For proof and documentation, life pictures through systematic observation and recording were taken with a digital camera. Information gathered through this means was used in the systems assessment part of the water safety plans.

4.6.2 Research interviews

There were 105 interviews conducted, nine of these with key informants. The details (age, sex, level of education, occupation, and status[25] in relation to well) are presented in Annex 5 – A5.1, Table A5. The full manuscripts of the interviews are presented on CD as Annex 5 – A5.2.

Scoping interview

A scoping interview was conducted at the start of the first field work to understand, in general terms, users' perception of self supply systems and water safety. The exercise was necessary to help the author in the formulation and design of interview questions.

Evolution of questions

Direct line of questioning on particularly health related matters resulted in denial and close-ended answers. For instance 'When was the last time you were sick'? Resulted in answers, '*I have never been sick*'! To elicit probable answers an indirect

[25] Three status in relation to well were used -owner, resident or non-resident user

questioning approach was adopted in which questions were reformulated around visits to hospitals, health care, and methods of disease treatments. For instance, '*What medication do you use when you are sick*'?

Evolution of interview styles

A respondent style of interview was adopted in the first field work (Robson, 2002). The style allowed interviewer's participation in the discussion but gave less respondent control. The author did not hide or disprove her identity as a researcher and a water management expert. Water sampling and testing activities carried out in situ established the researcher's identity. The inability to conceal the author's identity (water management expert) raised a concern of bias. The concern for the introduction of bias was however unfounded as respondents rather seized on the opportunity to pursue varied knowledge routes with the 'expert', a decision that is purely the respondents' choice. The author also was able to assess respondents' perceptions and attitudes to the subject matter. Equally the need for water made it difficult for respondents to act differently around wells even when an 'expert' is present. First hand observation of practices therefore helped the author to validate the respondents' statements.

In the second field work however, the interview style was changed, noting the opinion of Rubin and Rubin (1995) '*The purpose of qualitative interviewing is to hear and understand what the interviewees think and give them a public voice*". The author assumed the role of informed ignorance[26] to allow informant interviews (Robson, 2002). In informant interviews, the respondents provide all the information. The change allowed more respondent control and less information from the interviewer. The new style was used with different sets of users.

[26] Assumed a lack of knowledge role

Key informants interviews

Semi-structured interviews were used with key informants. A total of nine informants were interviewed in the course of the research to give background information on general water supply and to state especially the government perspective on self supply and water safety. The interview manuscripts are presented on CD as Annex 5 – A5.3. One of the key informants was an academic professor in Hydrology and Water Management. He was conversant with water management issues in the study area and Nigeria. Four of the key informants were senior officials in four of the government institutions, which were considered relevant to water management and safety. Two of the key informants were medical practitioners, and two herbal medicinal sellers and practitioners. Key informant interviews were conducted in the offices, work and market places of the academic and government officials, medical and herbal practitioners respectively. Duration of the key informant interviews varied from less than 30 minutes with the herbal practitioners to about 2hours with the professor. Apart from the medical and herbal practitioners, all the key informant interviews were pre-arranged. With the exception of the herbal practitioners, all the key informant interviews were conducted in English. The interviews of the herbal practitioners were conducted in the local language (Yoruba).

Selection of the key informants was primarily based on recommendations. The academic professor suggested names of the government officials by virtue of his knowledge of the relevant water agencies in the study area. Herbal practitioners were selected based on suggestions from respondents who were herb users. The two medical practitioners were each from the two primary health care centres, which was located within the study area.

Interviews of the respondents: methods and interviewees

As earlier reported, interviews became necessary as a result of the opportunity created by repeat visits to the selected wells (4.3.4). The scenario put no pressure on either the interviewer or the respondents. Conversations ensued freely and unhindered. Opinions were shared between the discussants. Respondents either refuted or supported the interviewers' comments with stated views, past examples or call to observe on-going events around the wells on any subject matter.

Owners and users of selected wells for water quality investigation formed the core of the interviewees. The interview sessions took place on location during water sampling, resulting in four interview sessions on four different dates at any well. As a result, all respondents did not comment on the same set of questions. Respondents on a particular interview session commented on same set of questions. That is all respondents in session one commented on same line of questions. At some of the sites the same respondents were interviewed on all four sessions. However, the trend (interviewing same set of users on all four sessions) was not true in all cases for all four interview sessions. The set of questions covered four main areas, namely the primary data of wells such as the age, number of users, and systems operation practices. The second group of questions focused on source and safety perceptions. The third examined water safety interventions and maintenance, while the fourth set of questions targeted health impact.

The free and available use of self supply wells allowed a cross-section of users to be interviewed. This helped to gain insight into the views of the varied group of users. Group differentiation was based on status of users in relation to wells; owners, resident users and non-residents. Resident users are occupants of the property where the well is located. Resident users therefore have unrestricted access to the wells. Non-resident users have restricted access to the well because they are not resident on the property. Non-resident users can however secure access to wells. A total of 96 respondents were interviewed; 24 source owners, 68 resident users and 4 non-resident users (Annex 5 – A5.1, Table A5). Of the 96 self supply well users, 80 respondents were interviewed in the first field visit with additional 16 respondents in the second field trip.

For the second field work, face-to-face interviews were conducted with owners and/or users of the 16 selected wells. Sixteen respondents were interviewed around the 16 wells; ratio 8:8 female and male respectively. Eleven respondents were resident users, and five were source owners.

The interviews were structured and sectioned into two parts. In the first section, questions were asked to obtain respondents' perceptions on the water source, operations, management, maintenance, household usage and handling, and on individual health and safety (Annex 5 – A5.4, Table A6). The second aspect was to seek respondents' opinions on the feasibility of the control measures to include in the water safety framework for self supply systems (Annex 5 – A5.5, Table A7; 5.2). The water safety framework was expected to be one of the research recommendations.

Prior to the interviews, the author took time to explain the mission, the need for the interviews to be recorded and requested permission to use a recording device. In all the cases, permission was granted. The second aspect of the interviews was conducted during the repeat water sampling days. By the second and/or third visits, respondents were observed to be more relaxed and talked/responded more than in the first visit. The opportunities created by repeat water sampling and consequently repeat visit/meeting with respondents helped the researcher to achieve the aim of getting the truth from respondents. Discussions flowed freely from matters arising especially on new observed activities or events around wells to verifying/clarifying previous respondents' claims.

All the respondents' interviews were conducted in a mix of both the local language (Yoruba) and in English. There was therefore no need for translators.

Interview timing

All the interview sessions with respondents took place in the morning to early afternoon hours between 8 am and 2 pm. The peak operation hours for hand dug wells are usually the morning hours. These hours also represent the sure time to meet owners/users around wells. The timing created the opportunity for the researcher to observe the wells, water handling, and users' behaviour around wells.

4.6.3 Triangulation

Triangulation in research facilitates validation of data through cross verification from usually more than two information sources. The self supply well selection criteria located wells but did not pre-empt the gender or self supply well owner/user status of respondents. It was however important to retain the owner/user of sampled wells as research subjects for the purpose of triangulation. So that interview results could be triangulated with findings from researcher's observation of the well handling and results from the quantitative sanitary inspections and water quality analysis conducted on sampled wells.

4.7 Data Analysis

4.7.1 Water quality results

Non-parametric statistics was used in the analysis of the water quality measurements because water quality data do not assume a normal distribution. Correlation coefficient[27], a non-parametric test was applied for its simplicity and robustness in a non-normal data set. This analytical approach is commonly used in water resources management (Helsel and Hirsch, 1992).

Field data of the electrical conductivity and the microbial parameters required conversion into analyzable units and format respectively.

Electrical conductivity

Electrical conductivity is generally affected by temperature. Water becomes less viscous and ions move more easily at higher temperatures. Hence conventionally,

[27] Correlation coefficient indicates the strength and direction of a relationship between two random variables. Random variables are used in the study of probability. The variables capture the mathematical properties necessary to answer probabilistic questions.

conductivity measurements are referenced at 25 ^{o}C. Also usually, the conductivity of most ions increases in conductivity by about 2% of their value per ^{o}C. The variation index allows for simple temperature compensation (Weast, 1978; ASTM, 2005). Consequently, the electrical conductivity measured in Milli siemens (Ms) was multiplied by a factor of 1000 to convert to Micro siemens per centimetres at the certain water temperature. The conversion to conductivity values at the referenced 25 ^{o}C followed the example in Box 4-2. It should be noted that the electrical conductivity meter used did not perform automatic temperature compensation.

To convert conductivity of 700 µs/cm at 30 ^{o}C to conductivity at 25 ^{o}C
Recall, conductivity variation index is 2% per ^{o}C
Therefore 2% of 700 µs/cm at 30 ^{o}C = [(2/100 * 700) * (30 ^{o}C – 25 ^{o}C)] = 70
The actual conductivity value at 25 ^{o}C is = 700 µs/cm – 70 = 630 µs/cm

Box 4-2: Conversion of electrical conductivity values at certain temperatures to values at 25 ^{o}C – the reference temperature

Microbial water quality parameters

Geometric mean values are used instead of the arithmetic mean for faecal coliforms and total coliform counts in Table 7-1 and 7-2 (7.1.1; 7.1.2). Very high levels of contaminations were detected and there were some extremely high values that exerted huge influence on the arithmetic mean. Helsel and Hirsch (1992) clarifies that microbial water quality is characterised by the presence of outliers and the inclusion of such result in analysis is important.

4.7.2 Risk assessments

Hazardous event approach was adopted for the qualitative risk assessment (Davison et al., 2005; Schmoll et al., 2006). The likelihood or frequency of occurrence of any identified hazardous event is scored on a scale of 1 to 5 against the impact or consequence expected from the hazard causing event. The score points of the impact is also on a scale of 1 to five. The resulting risk is computed as a product of the possibility of occurrence and expected impact. The criteria behind the scoring scales, adapted from Davison et al. (2005) are:

Likelihood (or frequency) of occurrence:

		Adapted criteria	**Original criteria**
5	Almost certain	More than once per day	Once per day
4	Likely	Once per day	Once per week
3	Moderate	Once per week	Once per month
2	Unlikely	Once per month	Once per year
1	Rare	Once per year	Once every 5 years

Consequences/Impact:

5	Catastrophic: Mortality expected from consuming water (i.e. causing death)
4	Major: Morbidity expected from consuming water (causing disease)
3	Moderate: Major aesthetic impacts possibly resulting in use of alternative, but unsafe water
2	Minor: Minor aesthetic impact causing dissatisfaction, but not likely to lead to use of alternative less safe source
1	Insignificant: No detectable impact

4.7.3 Interview analysis

Transcripts of the research interviews were made from the original taped conversations. Taped conversations were played back for transcription. Interviews made in vernacular were first translated and hand written. Translation however aimed for clear rather than verbatim transcripts. Grammatical corrections were made where necessary for further clarity without changing or influencing the meaning. The hand written transcripts were subsequently typed, generating over 81,000 words of data (Annex 5 – A5.2; A5.3).

Coding

Coding is an essential analytical process in qualitative research. The importance is to free the author from entanglement in the details of the raw data, and encourages higher level thinking about them (Neuman, 2003; Richards, 2006).

The coding analysis was guided by the research objectives and oriented towards the water safety plans framework. Coding of the interview data was done manually using the colour coding analysis. Interview responses on similar themes were highlighted in same colours. Same colour responses were then grouped into categories. The process started with open coding generating many initial codes from the data. The total numbers of codes or themes at the initial stage were high to maintain a wide range of codes to choose from. Subsequently, similar codes were merged or grouped into higher or lower level codes. For instance management problems were grouped under source management practices. The final list of codes is presented in Annex 5 – A5.6.

All the interview quotations or responses associated with coded themes were examined to identify related and/or contrast views, and to understand the factors or perceptions being expressed. Data descriptions and interpretations eventually followed within each major theme. The structure of the results and discussion chapters of the thesis are primarily laid out based on the major coded themes.

4.8 Research Constraints

Dependence on a local laboratory for the microbial water quality determination in a developing country context represented a major constraint to the research. Incomplete data sets were returned due to primarily logistic problems and inability to procure necessary culture media to time. Other factors included high turbidity and microbial contents of the water samples. The latter factors may be due to obsolete determination techniques. Incomplete data sets limited the data analysis. Logistical problems and/or obsolete determination methods also lead to the author querying the reliability of the microbial test results. As a result the nitrate-NO_3 contents of the wells are used more frequently in the water quality results analysis as a contamination index rather than the actual faecal coliform counts.

4.9 Reflections on Research Methods

This section highlights a few of the author's observations regarding research processes and approach. Three of such observations are discussed.

4.9.1 Theoretical versus field-based research methods

The author, through this research observed that theoretical (or desk) methodology designs do not always fit the actual field realities. For instance application of the sanitary inspection format saw two revisions or modifications to fit the realities presented in the field. In another instance, pre-formatted interview scenarios were not necessarily obtainable in the actual interview setting, especially in an event-based interview. The observation may not be uncommon in field based research but portrays a difference between theoretical research method development and field-based (or field generated) methodology.

The observation represents a decision making dilemma. The choice between published research concepts or the need to adapt to the practicalities in the field, while also considering some other factors like time, cost, and data reliability was challenging. The other queries were, for instance, in the event that modification was necessary, how and when do you draw the line between published methods and field-based methods or to what extent can you modify theoretical research models, and how acceptable are field-based methods?

Answers to the raised questions may be undetermined. In the first instance the need for modification may be inevitable. As seen with this research, many of the issues for inspection in the sanitary survey forms did not fit self supply systems' problems. Secondly, it may be necessary for a researcher to iterate method development to the extent that it can be justified within scientific and academically approved guidelines. In which case or to make the judgement, researchers need to draw on the available theoretical backgrounds. The issue of acceptability may however be subjective.

The presented dilemma and questions primarily call for reflection as there may not necessarily be right or wrong answers. However, the author opines that field based research requires a field based methodology development approach. In which research methods are allowed to evolve with events and field realities. With an understanding that there is a limit to how field realities can be construed behind the desk or off field. Arguably the place to start from is the knowledge of the basic or theoretical research methods but such background knowledge should serve only as a guide to possible iteration processes that may ensue. It should also be noted that field research deviates from abstract phenomenon. Field based research is expected to touch on practical real-life context. The author therefore suggests the need for less dogmatic research methods and strongly emphasises the need for more field based research methods within academic field based research.

4.9.2 Conversation versus structured/semi-structured interviews

The conversational discussions and interview style applied in the first field visit of the research yielded rich, more analysable and better descriptive responses relative to the interview results derived from the second field work. The conversational style of interview however has its draw back. The researcher has to decide promptly on the most important and relevant line of discussion to pursue per time within a fluid and free flowing discussion. The ability to make the right judgement in this regard remains a skill that researchers should acquire. The referred skill acquisition may however come from practice. In this research however, the opportunity of repeat sampling helped the author to re-enact discussions in topics, which needed more or better clarifications. In view of the field experiences, the author expresses a preference for a conversational style of interview, which puts no pressure on both the interviewer and the respondents, in research requiring qualitative data methods.

4.9.3 Hazards in research interviews

It is important to comment on a particular interview scenario, which can be classified as a research hazard. After an exchange of pleasantries and request for an interview, which was granted by an 80 years old female respondent, the author's first question – 'what do you use the well water for' was replied with volatile hostility and threats of being charmed. Every attempt to pacify the respondent was equally met with increased aggression. The author discreetly retreated through the help of other water users at the well. Further investigation was made to understand what triggered the respondent's reaction to the question asked. Investigation revealed that question relating to the usage of water had deeper connotation in occultism. One of the statements made by the 80 year old corroborated the suggested deeper connotation '*you are too small to ask me such a question….if you are sent to me, tell them you cannot deliver the message…*'!

The incident elicits concerns, among which are 'how can researchers recognise interview hazards'; 'how can researchers pre-empt and guard against related hazards'; and 'are there interview safety precautions'? Answers would be left to research practice and ethics deliberation. However, there is the need for awareness. It is important for researchers to be alert and guarded. It is also the opinion of the author to vet interview questions prior to actual interviews. Question vetting may be done with appropriate key informants to avoid the danger of misunderstanding. Question vetting may also be considered as an interview safety precaution in qualitative research practice.

4.10 Summary

This chapter described the background, theories, processes and events that guided the research actions. The chapter also explained the processes, from which the research data are generated. Method iteration represented a key process as it further shaped the research activities and the outcomes. Reflection on the research methods calls for interview safety vigilance.

Chapter 5 describes the conceptual framework of water safety planning for self supply systems. The framework sets the scene for the results chapters and the rest of the thesis.

PART II: RESULTS AND DISCUSSIONS

5 WATER SAFETY FRAMEWORK

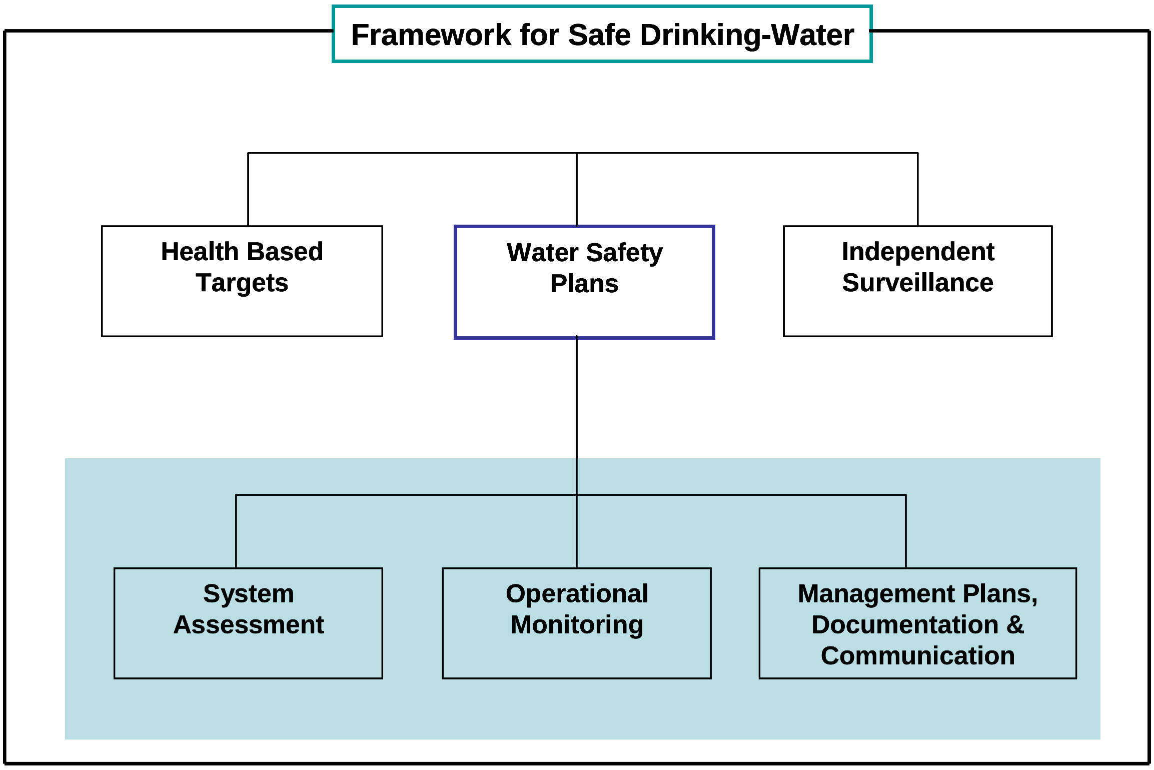
The research examines the relevance of water safety plans to a context in which urban water supply is by privately owned hand dug wells (self supply). This chapter provides the background necessary to follow the course of the research. The chapter presents the structure of the water safety framework, which forms the structure of the findings, and the layout of the rest of the thesis chapters.

5.1 Water Safety Plans in Context

The WHO in Davison et al. (2005 and 2006) outlines a preventive management framework for safe drinking-water that comprises five components, namely:

- Health based targets (based on an evaluation of health concerns)
- System assessment – to determine whether the water supply chain (from source through treatment to the point of consumption) as a whole can deliver water of a quality that meets the health-based targets.
- Operational monitoring of the control measures in the supply chain, which are of particular importance in securing drinking-water safety.
- Management plans – involves documenting the system assessment and monitoring; describing actions to be taken in normal operation and incident conditions – including upgrade and improvement, documentation and communication.
- A system of independent surveillance that verifies that the above are operating properly

The second, third and fourth of the five components, combine to form water safety plans (Figure 5-1).



Source: Davison et al. (2005)

Figure 5-1: Framework for safe drinking-water

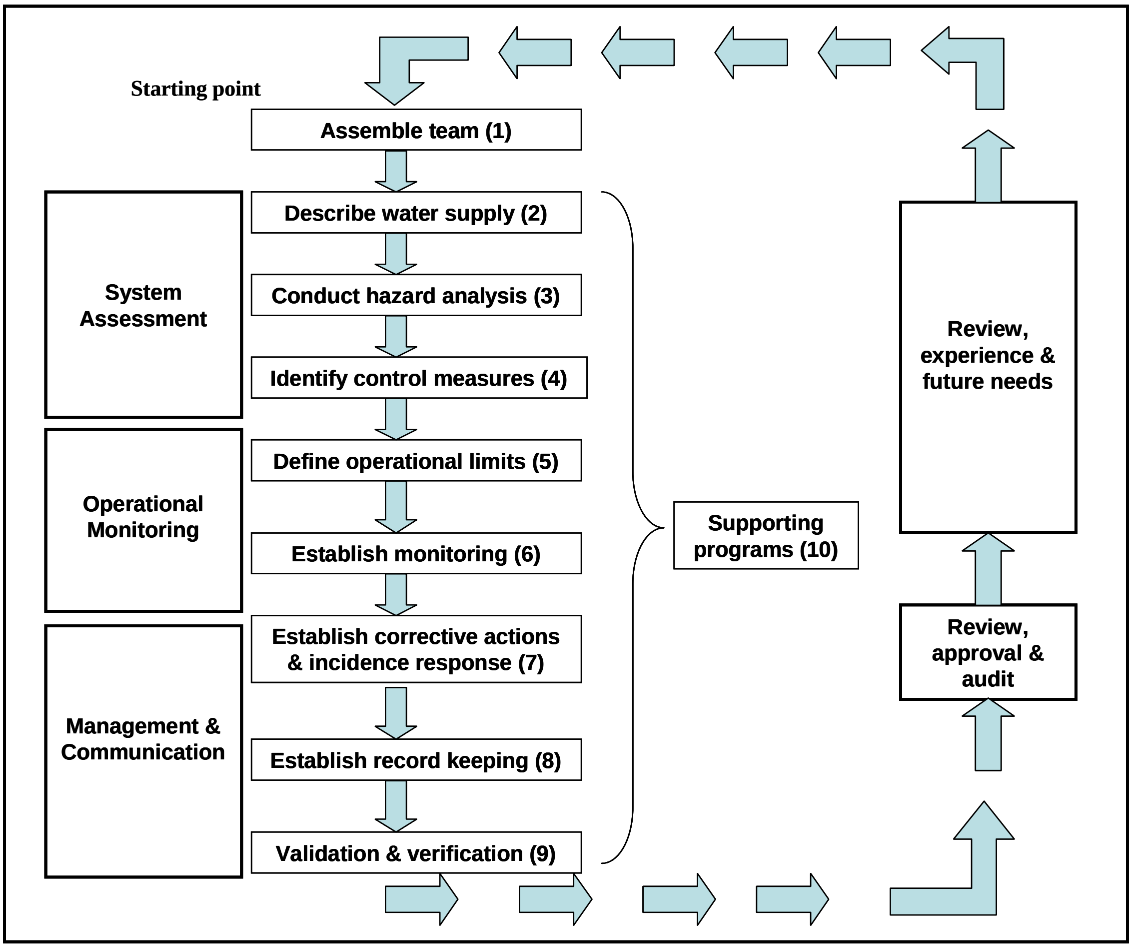
Specified along side the safe drinking-water framework are the roles and responsibilities of stakeholders who together ensure the provision of safe drinking-water. The broad stakeholder categories include the public health authorities, local authorities, and water supply agencies (WHO, 2004a; Davison et al., 2005). Schmoll et al. (2006) clarify that the establishment of health-based water quality targets would typically be led by the health sector, the surveillance component undertaken by a regulatory agency while the water safety plan is the responsibility of the water supplier.

WHO (2004a) and Davison et al. (2005) also outline the initial steps in the development of a water safety plan (Figure 5-2). These form the 10-step development guide to water safety plans:

1. Assemble a team to develop the water safety plan

2. Description of the water supply; the first step in system assessment
3. Hazard analysis or identification to establish what requires controlling in order to provide safe drinking-water
4. Identification of control measures to mitigate hazards
5. Definition of critical or action limits (criteria), which indicate whether the control measures are functioning as designed
6. Establishment of monitoring parameters, for instance turbidity and nitrate measurement to indicate contamination
7. Establishment of corrective actions; actions to be taken when the results of monitoring indicate a deviation from a critical limit
8. Establishment of record keeping; documentation to review the adequacy of the water safety plan
9. Validation and verification to establish that components within the water safety plan are working as expected and the plan as a whole delivers the required results
10. Supporting programs – activities that ensure the operating environment, the equipment and the people do not become additional sources of potential hazards to the drinking-water source. These may be necessary at any or every step

The framework for safe drinking-water, and the 10-step development guide to water safety plans form the essential backdrop for the research.



Source: Davison et al. (2005)

Figure 5-2: Ten steps in the development of a water safety plan

5.2 Towards the Formation of Self Supply Water Safety Framework

The WHO water safety plans and guidance steps are generally focused on applications to public utilities and community water supplies, with distinct catchment, treatment and distribution networks and with an identifiable provider. Water safety plans development for both public utilities and communal systems is possible because the responsibility to develop and comply with water safety guidance is placed on source owners (Davison et al., 2005; Schmoll et al., 2006). The ownership of both the public water utilities and community water sources are usually entrenched in governmental and/or non-governmental institutions. These institutions claim responsibilities for provision (and/or funding of public water suppliers), management, and in the case of public utilities, for maintenance and operations. In the wake of water safety plans, same institutions have called for and are involved in ensuring safety measures in the large scale water networks and the community systems. Presently however, water safety guidance for privately owned or self supply systems is yet to be developed.

Two factors may be associated with the current non-emergence of water safety guidance for self supply systems. The first factor is the type of ownership that surrounds self supply sources – individual or private. The second is the lack of an established institution or institutional framework to claim responsibility for the general management of individually owned water sources.

In terms of ownership, Schmoll et al. (2006) argued that water safety plans can be defined and applied through a generic approach for a technology type or developed for an individual supply using structured guidance. However, the activities required under the water safety plans are the responsibility of the water supplier. As is the case, many owners or operators of self supply sources lack the technical expertise or the competence of developing and ensuring water safety management of their sources (6.3.4). Many of these self supply owners are also not able to initiate the necessary actions required in water safety plans.

Recognition of the lack of technical expertise of source owners leaves the fate of water safety plan development for self owned sources with the second factor. The second factor is the need for an appropriate established institution to oversee and develop water safety guidance for self supply systems.

Consequently a four component water safety framework was formulated by the author for self supply systems (Figure 5-3). Three of the components were adapted from the WHO water safety plan outline, while the fourth component is driven by the need for an established institution to oversee self supply water safety planning. The four components are:

A. System description: - detailed understanding of the water source

B. Risks assessments: - assessment of the hazards/hazardous events, causes and risks associated with the water source

C. System management: - encompasses the following:
   - Source monitoring: - involves the supervision of:
     - Operations
     - Operators
     - Access to systems
   - Source improvements (upgrade, cleaning and maintenance)
   - Source and household water handling[28]

D. Systems institutional framework: - this can otherwise be referred to as systems managers. Systems managers are made up of two main subjects; the source owners (S) and the external institutions or influencers (Figure 5-4) The possible external influencers (with expected roles in parenthesis) are:
   - The government - E_1
     - Ministry of Water Resources - E_1^a (validation/verification/supporting programs)
       - ❖ Department of Community water supply and/or Department for Self supply systems[29]
     - Ministry of Health - E_1^b (validation and verification)
       - ❖ Department of Public Health
   - Educational Institution; University – E_2 (independent surveillance)
     - Department of Water Resources
     - Department of Microbiology and/or Environmental health
   - Regulators – E_3 (surveillance)
     - National Environmental Agency
     - Standards Organization

The underlying assumption of the framework is that the fourth component (Box D) must be functional for self supply water safety plans to materialise. Box D represents the most critical component on which the other boxes depend. For instance, the

[28] Handling refers to user's activities around source or household water e.g. keep bucket on the floor

[29] The Department or section for self supply systems is proposed; the department is not in existence

question of 'who' resides in Box D - who initiates a safety plan; who describes the system; who carries out risk assessment; who coordinates source management; who is responsible for validation and verification; who organises the supporting programs, the list is endless.

To answer the questions, a part of the interview sessions in the second field work was devoted to find out the workability or feasibility of the proposed framework (Figure 5-3). The feasibility was verified by asking five basic questions around each of the control measures and recommendations listed in Annex 5 – A5.5, Table A7. Answers to the basic questions form the core of chapter 10. The actors in Box D are identified in chapter 11.

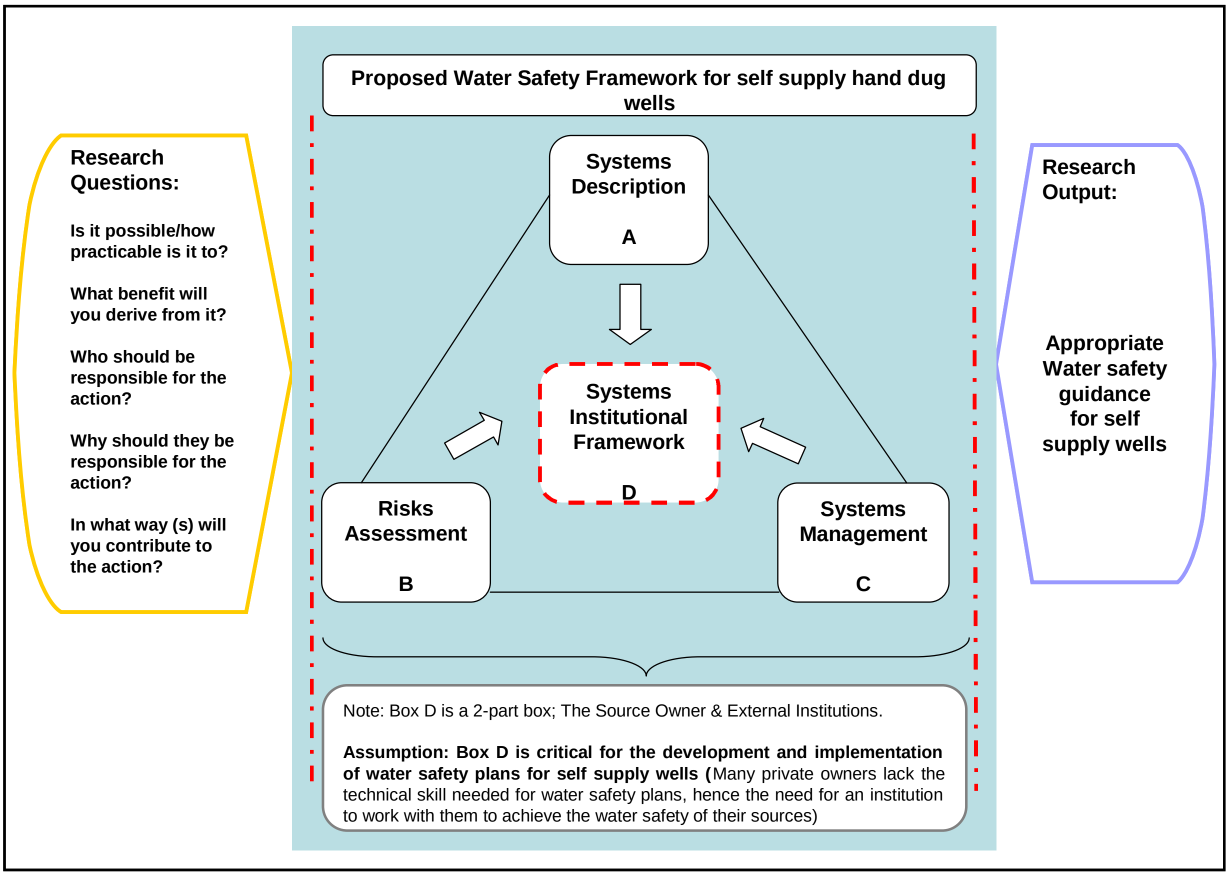


Figure 5-3: Proposed water safety framework for self supply systems

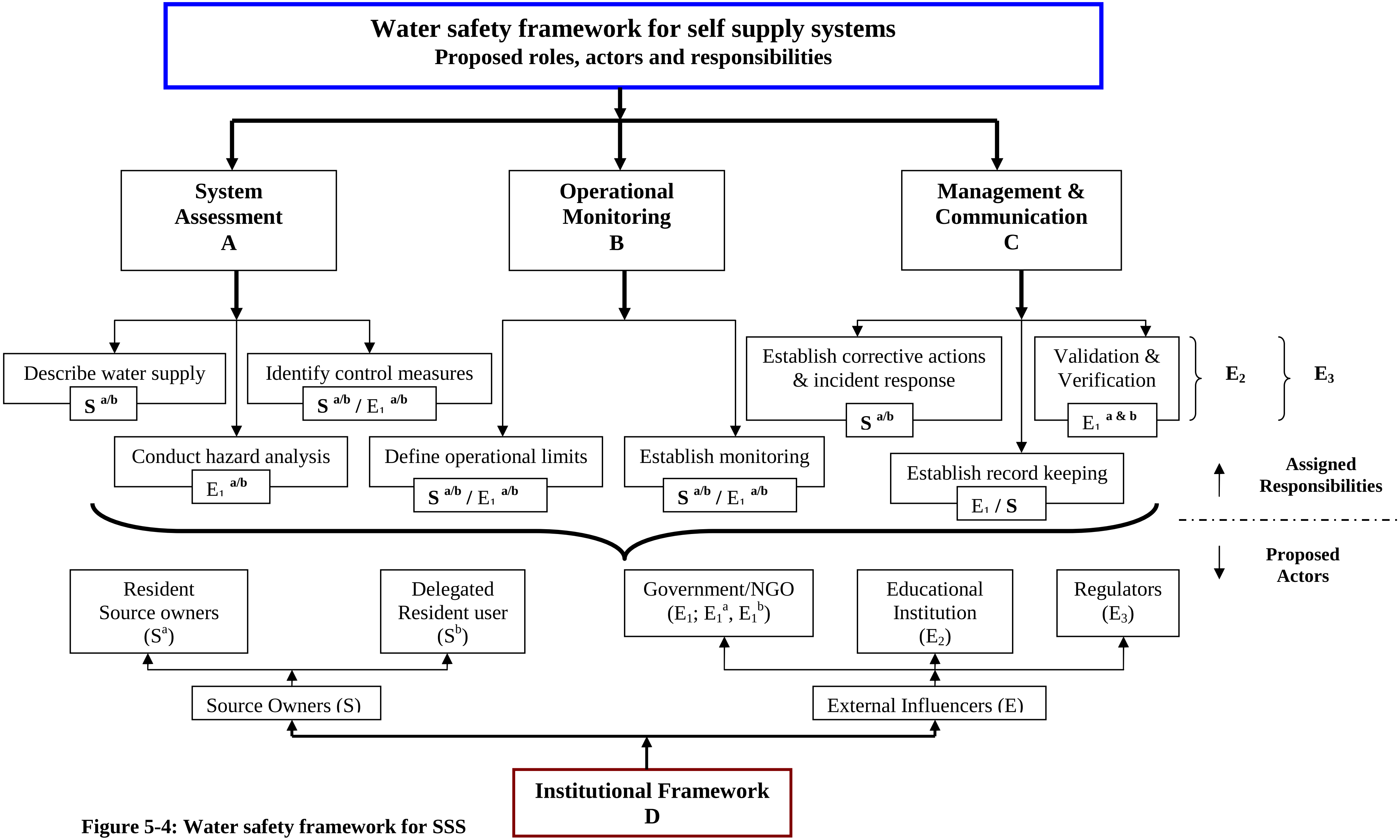


Figure 5-4: Water safety framework for SSS

5.3 Research Findings Outline

Boxes A and B in Figure 5-3 form the two major components of the system assessment. Chapter 6 describes self supply hand dug wells (Box A). Hazards identification and risk assessments of self supply wells (Box B) are detailed in chapter 7. The implications of self supply systems assessment to the development and implementation of water safety plans are highlighted and discussed in chapter 8. System management practices, which is the core of Box C in Figure 5-3 is described in chapter 9. Evaluation of the control measures is detailed in chapter 10, while chapter 11 describes the institutional framework. The concluding chapter (chapter 12) summarises the research findings, and presents an integrated discussion of the major highlights and implications for implementation of self supply water safety plans. The chapter also details the research recommendations, and ends with a closing statement.

6 WATER SUPPLY, WATER USES, AND WATER SAFETY PERCEPTIONS

The first step in water safety planning is systems assessment. System assessment uses information derived from system description and hazard analysis to assess the risks of hazards occurring in drinking water, and the potential of the system to control the risks (Schmoll et al., 2006). Consequently system assessment involves two stages; system description and hazard analysis. This chapter describes the most common self supply system in the study area, Abeokuta, Nigeria, and users' perceptions of water safety. A short chapter recap is presented at the end. Chapter 7 presents the hazard analysis.

6.1 System Description 1

The research findings set out in this section are structured under three major headings. The types of self supply sources available in the study area and numbers of the different sources are detailed under self supply inventory and types. The most common self supply sources are classified and each class is described with examples under the second heading. Heading 3 presents estimates of the number of users per water source.

6.1.1 Self supply inventory and types

Hand-dug wells and boreholes are the two main types of self-supply sources found in the study area. From the self supply inventory conducted, a total of 2, 280 dug wells and 38 boreholes are located within the boundary of Abeokuta (Figure 6-1). The average water table depth in hand dug wells is 4.5 m. Thirty seven of the 38 borehole owners did not know the depth of their borehole. The one owner who did know reported a depth of 30 m. This agrees with information supplied by a local driller who reported that most boreholes are drilled to a depth between 30 to 45 m, usually tapping 6 – 10 m depth of water.

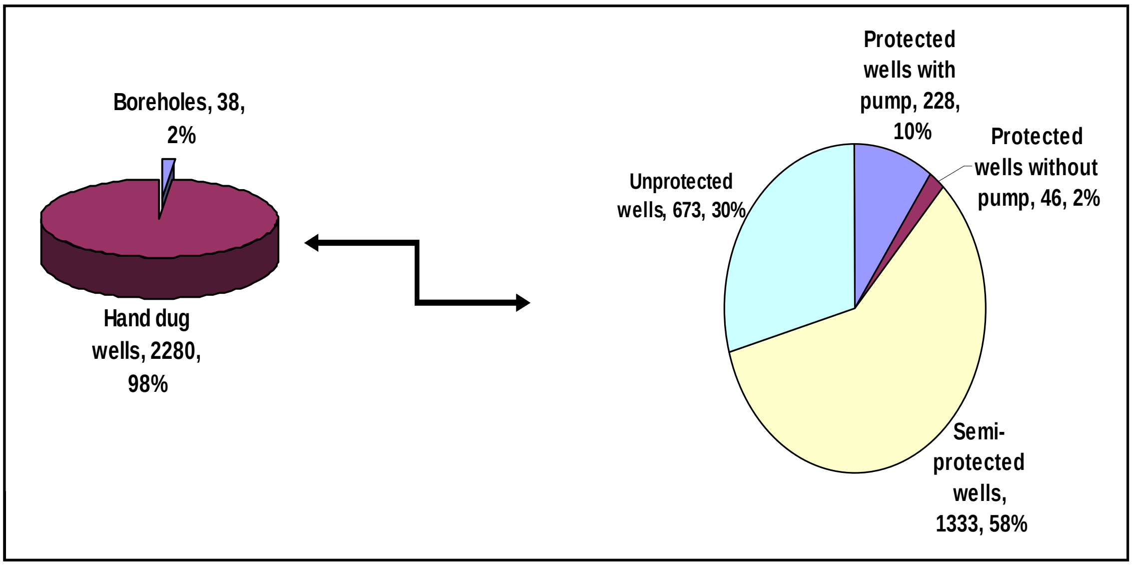


Figure 6-1: Self supply sources in Abeokuta, Nigeria

6.1.2 Hand dug well classifications

Hand dug wells are either protected, un-protected or semi-protected. In this study, a protected well (Figure 6-2a) is one equipped with a dedicated pump (manual or motorised), concrete lining and platform (or apron), head wall, cover, and drainage channel (Figure 6-3). Protected well definition is similar to the one given by Murcott (2007). An un-protected well (Figure 6-2b) is without any of the features above and a semi-protected well (Figure 6-2c) may have one or more of the features found in a protected well. For example, a well that is not lined is classified as semi-protected if it has a cover and an apron. The research informed classification (Table 4-a in Box 4-1; 4.4.4) is based on the structure of the well and the mode of operation.

Based on the above research well classifications, 12% of the hand dug wells in Abeokuta are categorised as protected (Figure 6-1). However, the water quality from protected wells can be impaired if the well is poorly operated. For example, for water abstraction, it is better to have a dedicated pump rather than a bucket and rope. In Abeokuta city, 10% of the hand dug wells have a dedicated pump, and 90% have bucket and rope (Figure 6-1). Most (58%) of the hand dug wells are however classified as semi-protected (Figure 6-1).

The types of access associated with protected, semi-protected and unprotected wells are discussed in section 6.1.3 of this chapter.

Figure 6-2: Examples of protected, un-protected, and semi-protected hand-dug wells in Abeokuta, Nigeria

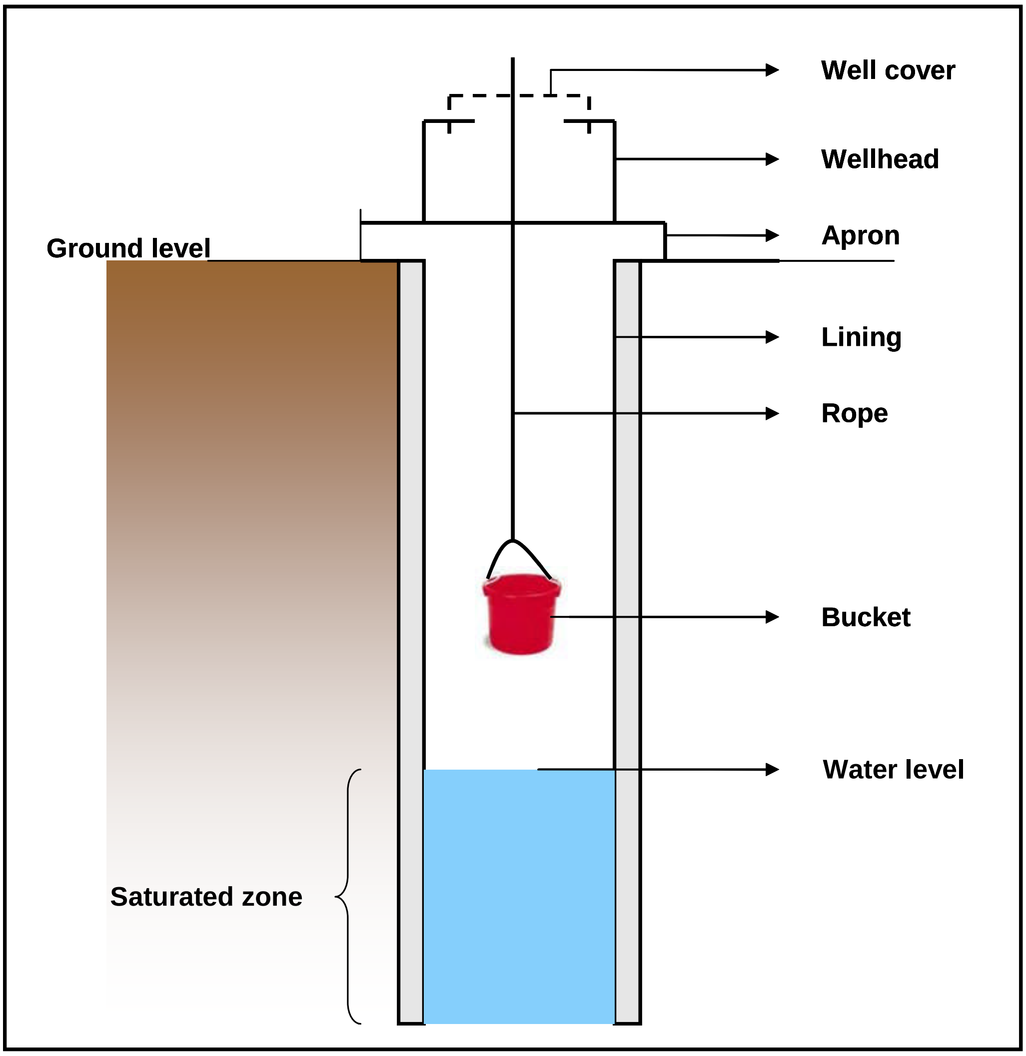


Figure 6-3: Features of a hand dug well

6.1.3 Type and number of users

Three types of well users were identified in the study area; source owners (SO), resident users (RU), and non-resident users (NRU). Calculating the number of users per well is not however a straight-forward exercise. Two approaches were used to derive an estimate for the number of well users. A first quick estimate was derived by dividing the human population figures with the number of wells in Abeokuta. The second method validates the derived estimate through interviews.

From the first approach, an average of 110 people uses each source. The estimated 110 user per well is calculated from year 2006 census figure (250,278) of Abeokuta population and the number of hand dug wells (2,280) obtained through inventory (Figure 6-1).

During the interviews the numbers of non-resident users in particular were estimated by respondents. In the following text the total number of interviewees is 28 and denoted by N. The numbers in parenthesis represent the serial number of the respondents.

Four respondents (25, 26, 28, & 16) out of 28 were able to give precise number of non-resident users (Table 6-1). Three (25, 26 & 28) of these 4 respondents gave actual numbers of NRU. It was possible for these respondents to give the actual number of NRU because NRU did not use their wells. The fourth respondent (16) gave actual number of NRU because neighbouring houses have wells, but there are a number of food vendors who are allowed access to well.

Thirteen respondents (one, five, six, 9, 13, 14, 15, 17, 18, 21, 22, 23, & 24) out of 28 provided an estimated number of well users (Table 6-1). Three (4, 17, 21) of the 13 respondents gave estimated numbers of NRU. One (6) provided an estimated number of RU and 9 of the 13 interviewees gave estimated total number of users.

Three (3, 4, 10) of the 28 respondents did not attempt to give any estimate of either RU or NRU. Sixteen (one, two, five, 7, 8, 11, 12, 16, 17, 19, 20, 21, 25, 26, 27, & 28) of 28 respondents however were able to count the number of RU and provide actual or precise figures (Table 6-1).

The average number of users per well derived from the numeric figures (actual and estimate numbers) reported by the respondents in Table 6-1, is 56 people per well. The derived average number of user from Table 6-1 is however underestimated when viewed in line with the actual answers given by the interviewees.

Table 6-2 presents the actual responses from which the average number in Table 6-1 is obtained.

From

Table 6-2, 21 of 28 respondents use the word ‘many’ or a word that connotes equal meaning to ‘many’ (e.g. lots) to indicate the number of well users. Nine of the 21 respondents who used the word ‘many’ gave an indication of what they meant by the word. One (21) of the nine respondents explained ‘many’ to be about 20. Two respondents (9, 17) claimed ‘many’ to be more than 50. Another respondent (13) said ‘many’ is about 70. Five respondents (one, 14, 15, 22, & 23) however made ‘many’ to mean more than 100 people. The implication of the various interpretations of the word ‘many’ is that the average number of users per hand dug well may vary from as few as 20 to more than 100 user. The upper band – more than 100 user per well – agrees with the estimated number (110 user per well) derived through the first approach that is described above.

Table 6-1: Respondents’ estimates of the number of hand dug well users. N = 28

SN	Resident status of respondents	Number of users		
		RU	**NRU**	**Total**
1	RU	56		100[a]
2	RU	168		168
3[b]	SO			
4[b]	RU			
5	RU	12	4[a]	16
6	RU	30[a]		30
7	RU	11		11
8	RU	25		25
9	RU			50[a]
10[b]	NRU			
11	SO	10		10
12	RU	27		27
13	RU			70[a]
14	RU			100[a]
15	SO			100[a]
16	RU	12	5	17
17	RU	10	50[a]	60
18	SO			200[a]
19	RU	17		17
20	RU	20		20
21	SO	15	20[a]	35
22	RU			100[a]
23	SO			100[a]
24	SO			50[a]
25	RU	14	0	14
26	RU	40	0	40
27	RU	19		19
28	SO	10	0	10
	Average number of users per well			**56**

[a] Numbers based on respondents guess or estimate; [b] Respondents did not provide any estimate; RU: Resident user; NRU: Non-resident user; SO: Source owner

Table 6-2: Actual responses to the question 'how many people use the well'? N = 28

SN	Respondents number	Responses
Group A – Free access		
1	1	'They are many, up to 100 ....'
2	2	'Many'
3	3	'The well is for the entire neighbourhood….'
4	4	'A lot, the entire households around here (12 houses)'
5	5	'They are many if there is no tap water'
6	6	'We are many….'
7	7	'Around 4 houses and people from the general hospital'
8	8	'Lots of people particularly when there is no public tap'
9	9	'We are many, up to 50; even people who come for parties use the well'
10	10	'I can't say, when there is no tap water, many people come here for water'
11	11	'No I can not give an estimate; they are many'
12	13	'About 70 people…'
13	14	'About a 100 people…'
14	15	'I can not give you precise figure, people are always here from morning till evening and they will be more than 100'
15	17	'You can say that more than 50 people come from outside….'
16	18	The well was constructed as a community well for people of Omida market and environs
17	19	'Many'
18	21	'…more than 20 people from outside come to fetch water here'
19	22	'The whole community comes here…> 100 or even 1000…'
20	23	'They should be more than 100 if counted'
21	24	'People from all these houses (5 houses) come here to fetch water; they will be more than 50'
Group B – Restricted access		
1	25	'Nobody comes from outside, it is strictly a 'mind-your-own business' house….'
2	26	'The well is for only those living in the house'
3	27	'We have very few; 1 or 2 non-residents coming occasionally'
4	28	'No non-resident users'
Group C - Gave actual numbers of both residents and non-resident users		
1	12	
2	16	
3	28	

Again from

Table 6-2, two types of access to hand dug wells are observed. These are free access and restricted access. While free access to wells is implicit in the responses of the respondents in Group A, restricted access is evident from the answers of the respondents in Group B. By superimposing

Table 6-2 on Table 6-1, the number of user per access type can be inferred. When non-resident users are declined access to the well (i.e. restricted access), the number of user per well is less than 50. When non-resident users are however allowed access (Free access), the number of users per well is generally more than 50 people. Fifty people per well can therefore be used as a threshold number.

As indicated in

Table 6-2, 21 (or 75%) of 28 respondents use a free access hand dug well. By using the above threshold number, a total of 85,500[30] (34%) people may be using free access hand dug wells in Abeokuta. An additional 11%[31] of users operate restricted access wells. By implication, 45% of the population in the study area may use either a free or restricted access hand dug well.

The available alternative drinking water sources in Abeokuta are public tap water, ‘pure water’[32], borehole and public hand pumped deep wells. Indication of the number of users of the alternative sources is provided in section 6.2.4. Water quality details of the alternative sources are given in section 7.1.1. It should however be noted that the most preferred tap water is generally not available to users on a regular basis.

In summary the average number of user per self supply hand dug well may be taken as 110 people. The upper band of the user estimated average validates the derived estimate of 110 people per well. The threshold number in terms of the types of access is however 50 users per source. By using the threshold figure of 50 users per well, an estimated 45% of Abeokuta population have access (either free or restricted) to hand dug wells. The estimated percentage should be considered high enough to justify the need to ensure water safety measures of self supply hand dug wells.

[30] 75% of 2,280 wells * 50 people

[31] 25% of 2,280 wells * 50 people /250,278 * 100

[32] Water in sealed sachet for sale as drinking water

6.2 System Description II - Water User Perceptions

The second aspect of system description explores the perceptions of water users. Water user perceptions is discussed under three headings namely hand dug well water uses, attitude of users to health impact, and attitude to water safety. The results for each heading are presented and discussed in turn.

6.2.1 Water uses

This section focuses on water uses. As explained in chapter 4, the conversational style of interviewing meant that the number of responses to specific sub-questions varies. In the following text the total number of interviewees is denoted by N (48). The variable numbers of respondents to specific sub-questions is denoted by N^I.

The key findings in this section are highlighted as follows:

- Water users separated the drinking water component from the definition of domestic water.
- Hand dug well water quality is perceived by users to be poor (or questionable).
- Hand dug well water is prioritised for non-drinking purposes.

Results leading to the three major findings and other related outcomes are presented and discussed below.

Answers to the question ‘do you drink well water’ are presented in Table 6-3. Fourteen of the 48 respondents claimed that they drink well water. Sixty percent of the 14 respondents drink well water unconditionally, 20% drink occasionally (The ‘O’ category) and the final 20% (the ‘C’ category) have a condition attached to when they drink the water.

Table 6-3: Answers to the question 'do you drink hand dug well water'?

	Outright Yes	No	Occasional	Conditional	Total
Number of respondents	8	34	3	3	48
%	17	71	6	6	100

For respondents in the 'O' category, the occasion for using well water for drinking is the absence of alternative sources and/or the chance to be the first to fetch well water early in the morning before any other users. Three alternative drinking water sources were mentioned by 40 of the 48 respondents (Table 6-4). The sources are tap water (70% of users), 'pure water' (25%) and borehole (5%). Tap water is thus the most preferred water source for drinking.

Table 6-4: Alternative drinking water sources specified by hand dug well users in Abeokuta, Nigeria. **N = 48; N^1 = 40**

Alternative drinking water sources	Number of respondents	
	Number	%
Tap water	28	70
'Pure water'*	10	25
Borehole	2	5

* Water in sealed sachet for sale as drinking water

The stated condition for drinking well water by the users in the 'C' category is the application of some form of household water treatment, especially in the absence of an alternative source. Examples of household water treatment given include the usage of Water Guard[33] or alum.

[33] Water Guard is a brand name for chlorine packaged as hypochlorite for household water treatment

Seventy one percent (34 of 48 respondents) said they do not drink well water. Eight reasons were stated by 33 of the 34 interviewees for not drinking hand dug well water (Table 6-5). From the eight reasons, three broad factors were found to be responsible for non-drinking of hand dug well water. These are the concern for safety - in terms of source, water and health safety (reasons 1, 4, 5, 6 and 7), aesthetic condition of well water (2, 8), and availability of alternative drinking water sources (3). Users prefer water that has either passed through some form of water treatment or that they will not need to boil before drinking. This preference is one of many that made the concern for safety the most referred factor as indicated by 22 (or 66%) of the 33 respondents (Table 6-5).

Table 6-5: Specified reasons for non-drinking of hand dug well water in order of frequency. **N = 48; N[1] = 33**

	Reasons for non-drinking of well water	No. of responses	% Frequency
1.	Safety[1, a]	9	27
2.	Taste	5	15
3.	Availability of alternative sources	5	15
4.	Lack of source water treatment [a]	5	15
5.	Influence of both multiple users and buckets [a]	3	9
6.	Poor hygiene [a]	3	9
7.	Need for boiling [a]	2	6
8.	Odour	1	3

[1] Safety is in terms of concerns for source safety (lack of well cover and un-kept well area), water safety (dirty water), and health safety (fear of contacting cholera); [a] Reasons relates to safety

The expressed preference to avoid drinking well water as shown in Table 6-5 thus suggests that hand dug well water quality is perceived rather poor or low by the users. The results of the water quality analyses of hand dug wells in the study area concur with this perception (Table 7-1).

Table 6-6 and Table 6-7 present all the water uses specified by users. The two tables also provide further indication of how hand dug well water is perceived by the users. Eight different types of water uses were mentioned. Column four (actual number of respondents) in Table 6-6 shows the number of users who mentioned each water use in addition to the number of responses that implied the particular water use. For example, bathing as a form of water use activity is considered implied in responses like ‘everything’ to the question of water usage.

Table 6-6: Answers to the question ‘what do you use hand dug well water for’? N = 48

Water uses	Number of times mentioned (a)	Number of times implied (b)	Actual number of responses (Frequency) (a + b)	Number of users who did not specify water use
Bathing	24	19	43	5
Cooking	21	12	33	15
Laundry	24	21	45	3
Drinking	8	6	14	34
Dish washing	8	33	41	7
Toileting [a]	7	37	44	4
Household cleaning	7	37	44	4
Productive uses [b]	8	8^2	8^2	40

[a] Include both anal washing, and toilet facility cleaning and/or flushing; [b] Productive uses are a mix of both ingested (food milling (1), food vendor business (2)) and non-ingested water uses (Tie and dye business (4) and washing of farm produce (1)). The numbers in parenthesis represents the number of time each productive use was mentioned. Productive use of water is not presumed to be implied because not all households or individuals engage in productive use activities;

Table 6-7 presents all the mentioned water uses in order of frequency. From Table 6-7, two broad categories of well water uses are identified; the ingested (direct or deliberate water consumption uses) and the non-ingested water uses. Also from Table 6-7, 17% of users engage in productive uses. Productive uses are a mix of both ingested uses (food milling), and non-ingested uses (tie and dye business) but generally not all households or individuals engage in productive use activities. In addition, only about 30% of users will drink well water. About 70% will cook with the water while more than 85% (between 85 to 94%) users will use well water for non-ingested purposes.

Two points can be inferred from the derived percentages in Table 6-7. The first inference is that hand dug well water is prioritised for non-ingested uses of especially laundry, toileting, household cleaning and bathing. Secondly, the percentage of users (>85%) who use well water for non-ingested purposes further confirm that users' perceived hand dug well water safety to be questionable or poor.

Table 6-7: Water uses in order of frequency, percentage frequency, and category. **N = 48**

Water uses	Actual number of responses (Frequency)	% Frequency	Water use category
Laundry	45	94	NI
Toileting [a]	44	92	NI
Household cleaning	44	92	NI
Bathing	43	90	NI
Dish washing	41	85	NI
Cooking	33	69	I
Drinking	14	29	I
Productive uses	8	17	NI & I

NI: Non-ingested use do not involve direct or indirect water consumption to human body; I: Ingested use involve direct or indirect water consumption to human body; [a] Include both anal washing, and toilet facility cleaning and/or flushing.

If the cooking component of domestic water is considered as a form of water consumption (or ingestion) as implied, among others, by White et al. (1972) and Thompson et al. (2001), then the percentage of respondents consuming hand dug well water rises to about 70% (Table 6-8).

Table 6-8: User-defined water use categories. N = 48

User-defined water use categories	Frequency	% Frequency
All domestic including drinking [a]	13	27 [c]
All domestic excluding drinking [a, b]	20	42 [c]
All domestic excluding cooking and drinking [a]	10	21
Selective domestic (e.g. only laundry or bathing)	5	10

[a] Separated drinking from domestic water; [b] Category included cooking component of domestic water; [c] Percentages of users that ingest hand dug well water.

Apart from the specified domestic uses of bathing, cooking, laundry, dish washing and drinking as shown in Table 6-6 and Table 6-7 (user specified water uses), there are also four other water use categories mentioned by the users. The four water use categories are here referred to as user defined. The user defined water use categories are ‘all domestic including drinking’, ‘all domestic excluding drinking’, ‘all domestic excluding drinking and cooking’ and ‘selective domestic’ – e.g. only laundry (Table 6-8). ‘All domestic’ as defined by users is exclusive of the drinking water component. ‘All domestic excluding drinking’ is a typical first answer to the question of ‘what do you use hand dug well water for’?

From Table 6-8, 90% of respondents separated the drinking water component from domestic water. Separation of the drinking water component from domestic water is however found to contrast with the standard scientific or academic perception/definition of the term domestic water. Generally, the first major component in the academic definition of domestic water is drinking water (WHO, 1993; USGS, 2000; Howard and Bartram, 2003; Moriarty and Butterworth, 2003; WHO, 2004a).

User defined water use categories are based on how the water quality is perceived. When a source water quality is perceived to be good, the source water is drinking water. When the quality is however perceived as questionable, the source water is good for domestic excluding drinking.

From Table 6-7 and Table 6-8, a relationship between perception (water quality and/or safety) and water use can be implied. Depending on the level of perceived water quality or safety, usage graduates from selective domestic (e.g. only laundry) to domestic excluding cooking and drinking, domestic excluding drinking, and finally to domestic including drinking. The percentage of users that will use well water for uses requiring good quality decreases from more than 85% to less than 30% (Figure 6-4). The use that a water source is put to therefore depends on how the water quality or safety is perceived. This finding is corroborated by Madanat and Humplick (1993), who found that the use of water from particular sources may be determined by the perception of the users concerning the quality of that water.

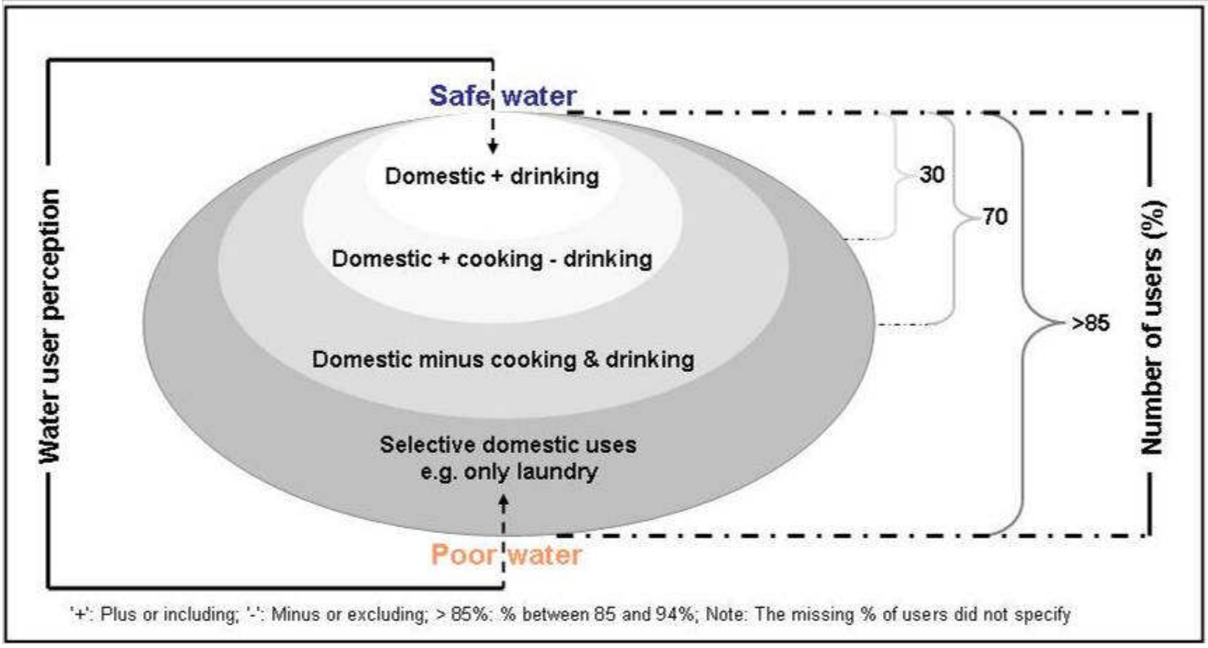


Figure 6-4: Water user perception of water safety and quality with corresponding water use gradient and number of users (%) per water use category.

The water quality requirements associated with the user specified water uses can also be deduced from Table 6-8. Water uses for which good quality is needed are presented in order of quality in Table 6-9. In the Table, four water quality ratings are shown. The identified water quality groups are inferred from the four user defined water use categories in Table 6-8. From Table 6-9, the deduced user perceived water quality ratings vary by two steps when compared with the internationally accepted water quality requirements. Internationally, drinking water quality standard is generally accepted for many of the household water uses except for water needed for toilet flushing (Howard and Bartram, 2003). Waste water re-use has been suggested for toilet flushing (Fewkes and Ferris, 1982; REA, 2009).

Table 6-9: User defined water uses: local perceptions versus internationally accepted water quality requirements.

Water uses	**Water quality rating**	
	Local perceptions *	**Internationally accepted****
Drinking	1	1
Cooking	2	1
Dish washing	2	1
Bathing	3	1
Laundry	3	1
Toileting		
▪ Anal washing	3	1
▪ Toilet facility cleaning/flushing	4	2
Household cleaning	4	1
Productive uses		
▪ Non-ingested productive uses	4	2
▪ Direct ingestion productive uses	1	1

1 = First grade (Good) quality; 2 = Second grade quality; 3 = Third grade quality; 4 = Fourth grade (Least) quality;
* Local perception water quality ratings are deduced from the four user-defined water use categories in Table 6-8;
**: Howard and Bartram (2003)

Certain observations suggest that the number of people who ingest hand dug well water may be more than the number estimated from the interviews. Figure 6-5 presents an example of such an observation. The figure shows a mother struggling to prevent her baby from drinking hand dug well water during bathing. The observation took place at a well where the users claim that the hand dug well water is strictly for bathing and laundry purposes. It is not also ascertained the extent to which hand dug well water is boiled by the respondents' who claimed to cook with hand dug well water. The extent to which water is boiled may indicate whether any form of microbiological contamination that may be present in the well water is eliminated.

(Source: Research field data 2007)

Figure 6-5: A mother preventing baby from drinking hand dug well water during bathing. Insert is the well from which bathing water was taken.

In conclusion, it is evident from the various results presented in this section that the user perception of hand dug well water is that it is of low quality. Hand dug well water safety and quality is seen as questionable. Consequently, usage of hand dug well water is mostly limited to non-drinking uses. However, where more than half the population ingest water in the form of cooking and/or dish washing from a particular source, it should be considered appropriate to provide safety guidance for the usage of such water sources.

6.2.2 Perception of health impact

Asking direct health related questions generated closed-ended or improbable answers. For instance, 'have you had cholera before'? Typical answer, '...God forbid such in our area…'! To probe into respondents' attitude to health matters therefore, an indirect line of questioning was adopted. Box 6-1 presents an example of a conversational interview scenario on health issues. The Box shows a switch from direct questioning after a typical ‘God forbid’ answer to indirect questions like ‘how do you treat yourself when sick’, or ‘have you been to the hospital before’?

I:	*‘……but now that it has become a health hazard or can cause infection…*
R_1:	*God will not allow such to happen, we will never see sickness.*
I:	*If you are sick what do you do?*
R_1	*Never; I’ve never been sick*
I:	*Never?*
R_1:	*It is over 20 years*
I:	*What about your children?*
R_1:	*Once I use chloroquine (a brand of anti-malaria drug) and etcetera for them, they were okay*
I:	*Do you go to hospital when you are pregnant?*
R_1:	*No, I only lose appetite for food. They’ve never allowed me to be admitted in the hospital unless when I have to put to bed….*
I:	*How do you know it is chloroquine that you have to use?*
R_1:	*I don’t use anything quinine, even my children I use Fansidar (a brand of anti-malaria drug) for them*

Source: Field study, 2007; I = Interviewer; R = Respondent

Box 6-1: A conversational interview scenario on health related matters

The indirect questioning approach on health associated matters resulted in findings related to the following topics:

- Users’ attitude to health impact
- Factors influencing attitude to health impact
- Major prevalent ailments or sicknesses and causes
- Types of treatment, treatment categories, and forms of medications

The results leading to the main findings are presented and discussed below.

6.2.3 Users' attitude to health impact

Sixty one respondents commented on health related matters. As shown in Table 6-10, the initial reaction of more than half (53%) of the respondents to the question of sickness is denial. '*I have never being sick*', '*I do not fall sick*', or '*Never; sickness is not my portion*' are common responses. While 26% denied diarrhoea diseases, 27% claimed that they do not fall sick at all or not often. This apparent general denial of sickness is here referred to as denial syndrome or denial attitude to health.

Table 6-10: Users' attitude to sickness; N = 61

	Denial		Admit sickness	Total
	Diarrhoea	**Being sick at all**		
No. of responses	16	17	29	62*
%	26	27	47	100
%	53			

* Overlap in responses. One respondent denied diarrhoea and being sick at all

Factors influencing water users' attitude to health impact

The denial of water users to health impact is influenced by five factors (Figure 6-6). The factors are deduced from 38 (N^I) of 61 responses (N). The five factors are the degree of seriousness that users attach to disease/sickness (14 respondents or 36%), the time factor between last sickness and current health status (9 respondents or 24%), users' religious belief (8 respondents or 21%), the sense of immunity to source water (4 respondents or 11%), and limited knowledge of particular diseases (3 respondents or 8%). The five factors are discussed in turn.

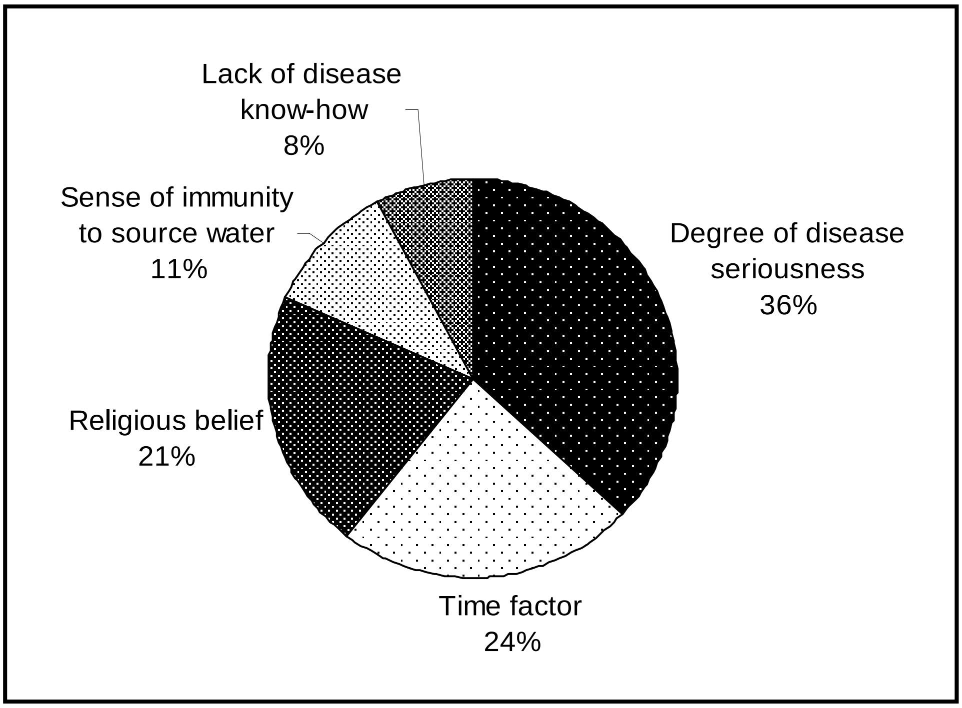


Figure 6-6: Factors influencing water users' attitude to health impact. N = 61; N^I = 38

1. Degree of disease seriousness

Water users' perception of the degree of disease seriousness is responsible for 36% of denial (Figure 6-6). The degree of disease seriousness thus represents the most influencing factor on users' attitude to health impact. When sickness is perceived as minor, then users are not sick. When the illness is however considered serious, then that is sickness. Examples of minor illnesses are headache, cold and/or malaria, whilst typhoid, cholera or any diarrhoea related diseases usually qualifies as serious sicknesses (Box 6-2).

I:	*So no one here has had cholera before?*
R_3:	*Among us? Never*
I:	*The germs found in the water can cause cholera, diarrheal, etc...What about dysentery?*
R_3:	*We would never see that here.*

R_{27}:	*I don't get sick*
I:	*You expect us to believe that you have never been ill?*
R_{27}:	*I've been sick but not recently…*
I:	*What was the illness?*
R_{27}:	*It was cold (flu)*

I:	*What do you do when you are sick?*
R_{28}:	*I really do not get sick, so I do not know how to answer that.*
I:	*You've never fallen sick before?*
R_{28}:	*No; may be slight headache, which comes and goes …I have not been seriously sick since I grew up*
I:	*What about your children?*
R_{28}:	*No, not recently. They also don't fall sick*

I:	*When you are sick what do you do, I mean how do you treat yourself?*
R_{73}:	*I don't normally fall sick, except if I have malaria.*
I:	*Except malaria? Is malaria not a form of sickness?*
R_{73}:	*Not really, I have malaria when I have serious mosquito bites*

Source: Research interviews; I = Interviewer; R: Respondents

Box 6-2: Sickness denial (denial syndrome) based on the degree of seriousness that water users' attach to sickness

2. Time factor

Time factor denotes the time interval or length of time between date of last sickness and current health status. Time factor is responsible for 24% of denial (Figure 6-6). When the time factor is considered long by users, then the user claims 'I do not get sick'! A long time however means a different time span to different users. Box 6-3 highlights various interpretations of 'long time' as explained by five of the nine respondents from whose answers the time factor was deduced. In Box 6-3 the length of time is a range from one year (last year) to 20 years (from top down).

R_{27}:	*I don't get sick*
I:	*You expect us to believe that you have never been ill?*
R_{27}:	*I've been sick but not recently*
I:	*When last was it?*
R_{27}:	***Last year***
I:	*How do you take care of yourself when sick?*
R_{94}:	*I was last sick **2-3 years ago.***
I:	*Did any of your children have diarrheal or cholera?*
R_{50}:	*They never have it.*
I:	*Is it that they never have it or it has been a long time since they had it?*
R_{50}:	*It has been a long time, about **seven years ago.***
I:	*How do you treat yourself when sick?*
R_{93}:	*I don't get sick, not even once in the last **10 years**!*
I:	*If you are sick what do you do?*
R_1	*Never; I've never (been) sick*
I:	*Never?*
R_1:	*It is over **20 years***

Source: Research interviews; I: Interviewer; R: Respondent

Box 6-3: Time factor influence on denial attitude of water users to health impact

3. Religious belief

Belief in God, the Supreme Being is responsible for 21% of denial (Figure 6-6). Religious belief is inter-related with perceived degree of sickness seriousness. Users are quick to reject or ward off the occurrence of any disease that they perceived to be serious whenever the disease is mentioned or referred to. Warding off seems to make the disease go away or prevent the sickness. It however appears that warding off the occurrence of serious diseases is not enough without the expression of faith or belief in the Supreme Being who is considered able to prevent the disease. The above presumption tied to the expression of faith or belief is evident in 8 of 38 responses as shown in Box 6-4. Examples of such expression of faith include '*God forbid*', '*…Jesus is my Healer*', '*...we pray that such will never happen in our area*', and '*Thank God, I have never been to the hospital*' (Box 6-4)!

R_1:	***God will not allow such to happen**, we will never see sickness.*
I:	*Your water was tested and found to contain E. coli, a germ that can cause cholera or diarrhoea.*
R_{20}:	***God forbid such in our area**.*
I:	*Do you know if any one here has had cholera before ……..*
R_{46}:	*Mummy said **God has not allowed that to happen**.*
R_{53}:	*No**; we don't pray for Cholera**, we don't have it around here*
I:	*When your children are teething, what do you use for them?*
R_{53}:	*We use Bonababe (brand name of teething medication)*
I:	*What about typhoid fever?*
R_{68}:	***No, that will not happen to us in Jesus name**. We never had that before*
I:	*Not to you and the children?*
R_{68}:	***By the grace of God, no***
I:	*What about diarrheal?*
R_{68}:	*Not my child*
I:	*Ok, when did you go to hospital last?*
R_{78}:	***Thank God I have not been to the hospital***
I:	*Do you mean that you have not been to the hospital all your life?*
R_{78}:	*No, I mean that I have not been to the hospital this year*
I:	*What happened to you when you went last?*
R_{78}:	*I had malaria*
R_{94}:	*I was last sick 2-3 years ago. It was normal fever and I use self medication. Presently however, I live on divine health. ''**Divinely we are sustained''**!*
I:	*How many times have you been sick in the last 6 months?*
R_{96}:	***None, Jesus is my healer**!*

Source: Research interviews; I: Interviewer; R: Respondents

Box 6-4: Expression of faith or belief: influence of religious belief on denial of sickness

As shown in Box 6-4, warding off sicknesses by the expression of faith or belief do not imply that the user has not been sick or was never sick as claimed. Rather, sickness denial through the expression of faith or believe conveys two points. The points that:

- The Supreme Being who is believed, is able to and will prevent the occurrence of especially serious diseases (R1, R20, R46, R53, & R68)
- The Supreme Being sustains good health status (R78, R94, & R96).

Although the ability of the Supreme Being to prevent diseases and sustains good health is not in question, the two points convey an inherent danger. That is the danger of users shifting part or all of the responsibility of disease prevention and health management to the Supreme Being. The implication of the identified danger is that water safety measures necessary to ensure water and invariably human health safety may be compromised by religious belief, and denial attitude to sicknesses that the belief fuels.

Water safety planning is expected to impact (prevent water borne or related diseases and improve health status) on health if adopted and implemented (WHO, 2004a). Thus water safety plans represents the role of man in disease prevention. Water users may not however see the need to adopt source and household water safety plans to prevent sicknesses as there is a God who is deemed responsible for disease prevention and good health.

It would therefore be necessary to promote enlightenment programs to highlight or focus on water users' role in disease prevention. Acknowledge the ability of the Supreme Being in disease prevention but emphasise individuals' responsibility and role as well. It would also be important to involve religious leaders in enlightenment programs for participation and teaching on the role of God and man in disease prevention.

4. Sense of immunity to source water

Eleven percent or four of 38 respondents denied especially water borne diarrhoea or related cholera by statements that literarily connote a sense of immunity to source water (Figure 6-6). Statements from the four respondents are presented in Box 6-5.

I:	*It contains E. coli that causes cholera and diarrhoea….*
R_{23}:	*Well it may contain it but there is no one here who has had cholera since I have been using the well*
I:	*What do you think can cause such things since you are the user?*
R_{26}:	*We use it, drink and cook with it and nothing happened to us*
I:	*Since when have you been living here?*
R_{26}:	*1994*
I:	*And no one has had cholera?*
R_{26}:	*No*
I:	*But you also use it for dish washing?*
R_{55}:	*Yes even for bathing and it causes nothing.*
R_{71}:	*This is the water we have been using. It is the water that I drink and use. And I have never been affected by cholera or anything*

Source: Research interviews; I: Interviewer; R: Respondent

Box 6-5: Respondents statements that suggest sense of immunity to source water

The statements presented in Box 6-5 may however have more than one interpretation. For instance *'…we use it (hand dug well water), drink and cook with it and nothing happened to us…'* may be interpreted in one of two ways. Firstly, 'if indeed cholera causing germ is in the water and I have not had cholera since using the water, then I am immune to cholera or the causing agent'. Secondly, 'if I have been using the source water for this long and I have not been infected with cholera, then cholera causing agent can not be in the water'! Consequently the following hints are summarised from the statements in Box 6-5:

- No water borne disease (diarrhoea/cholera) is suffered since usage of water source (R23, R26, R55, & R71; all four respondents)
- Users are immune to disease-causing agents if indeed the agents are present in water as claimed (R23; one out of four respondents)
- There are no disease-causing agents in water as claimed (R26, R55, & R71; three out of four respondents)

From the above summary all four respondents denied diarrhoea or cholera disease. A statement from one (R23) of the four suggests immunity to disease causing agents and admits to link between disease-causing agents and water – *'…well it (the hand dug well) may contain it (E. Coli) but there is no one here who has had cholera since I have been using the (hand dug) well'*. Three out of four respondents however gave the indication that there are no disease-causing agents in their waters – *'….this is the water we have been using…..and we have not been infected with cholera....'* The responses of the latter 75% of users imply that there is the possibility that larger percentage of users may not be making the link between disease-causing agents and medium of disease transmission, water.

The inferred possibility represents another concern for water safety planning. Clear understanding of water borne diseases, their causes, and transmission pathways/route is essential. The understanding may facilitate or help users to see the need to take water safety measures to protect their water sources for improved health. Education on water borne or water related diseases, causes and transmission pathways is therefore worth including in enlightenment or water safety plans supporting programs.

5. Lack of disease know-how

Water users' lack or limited knowledge of diseases is the fifth force behind denial. As shown in Figure 6-6 the fifth factor is responsible for 8% (3 of 38 respondents) of denial of users to sicknesses.

Water users exhibit lack of knowledge of especially the water borne sicknesses through their responses. In the dialogue shown in Box 6-6, two (R24 & R43) of the three respondents denied sickness in children *('…nothing is wrong with them…')* but admit that children has been teething. The dialogue in Box 6-7 presents what users mean by teething in children – frequent stool with temperature. The third respondent (R53) particularly denied diarrhoea related sicknesses but admit to teething in children. From Box 6-6 therefore, teething in children is obviously not regarded as diarrhoea or diarrhoea related disease and consequently not related with water. Water users' description of teething in children is similar to the description of diarrhoea in medicine. In medicine, diarrhoea is characterised by frequent loose or liquid bowel movements. By implication therefore, teething in children is diarrhoea. That water users do not understand/take teething in children to be diarrhoea can be viewed as disease misrepresentation and an evidence of lack of disease know-how.

It should be noted that 98% of diarrhoea is as a result of poor water, sanitation and hygiene. Diarrhoea is responsible for about 2 million child deaths per year (JMP, 2005; 2008). Food, faeces, flies, fingers, and water are notable faecal-oral routes of disease transmission (Percival et al., 2004). Three of the five noted routes have either a direct or indirect link with water. Ingestion of unsafe water represents a direct link, while food and fingers (through food/fruit, plate or hand washing for instance) represents indirect link with water.

The identified disease misrepresentation will thus cloud the link between water and water borne diseases like diarrhoea. Disease mismatch will also preclude the importance of ensuring safety measures of sources by users, and invariably undermine the need for water safety plans.

I:	*Aunty what is wrong with your child?*
R_{24}:	*Nothing*
I:	*They said he is teething*
R_{24}:	*Yes*
I:	*What did you use for him?*
R_{24}:	*We took him to the hospital in Lantoro (The biggest private hospital in Abeokuta)*
I:	*Which drugs were they given?*
R_{24}:	*I don't know it*
I:	*Is it Bonababe?*
R_{24}:	*I don't know.*

I:	*Ok, what is wrong with your child?*
R_{43}:	*my child? Nothing, there is nothing wrong with him*
I:	*We heard that he is teething*
R_{43}:	*Yes*
I:	*What did you use for him?*
R_{43}:	*We took him to the hospital, Duro hospital; it's very close to this place*
I:	*Which drugs were you given?*
R_{43}:	*I don't know it*
I:	*Is it Bonababe?*
R_{43}:	*I don't know.*

I:	*Do they have dysentery?*
R_{53}:	*No; we don't pray for Cholera, we don't have it around here*
I:	*When your children are teething, what do you use for them?*
R_{53}:	*We use Bonababe (Brand name for a local teething medicine)*

Source: Research interviews; I: Interviewer; R: Respondents

Box 6-6: Lack of disease (diarrhoea) know-how exhibited by water users

I:	*Good day aunty*
R_{37}:	*Thank you*
I:	*Your child has stopped teething?*
R_{37}:	*Yes*
I:	*What was the problem he had?*
R_{37}:	*He had temperature and he was stooling (loose or watery excrement)*
I:	*When last was that?*
R_{37}:	*About 2 months ago*
I:	*Which drug did you use?*
R_{37}:	*Bonababe*
I:	*Who asked you to use the drug?*
R_{37}:	*It was advertised on the Television*
I:	*Is it not prescribed by a doctor?*
R_{37}:	*No*
I:	*Does the drug work after use?*
R_{37}:	*Yes*
I:	*Has it happened again?*
R_{37}:	*No*
I:	*How frequent was the stooling?*
R_{37}:	*Like twice in a day*
I:	*What type of water are you using for him?*
R_{37}:	*Tap water*
I:	*Did you add anything to the water?*
R_{37}:	*No*
I:	*Do you bath him with well water?*
R_{37}:	*No*

Source: Research interview; I: Interviewer; R: Respondent

Box 6-7: Interview dialogue presenting water users description of teething in children

Major prevalent sicknesses and causes

Twelve types of ailments are mentioned by water users (Table 6-11). The most commonly referred to of the twelve ailments is malaria (42%). Diarrhoea and diarrhoea related diseases (12%) and typhoid (11%) are rated second and third respectively in terms of the number of times the diseases are mentioned. Cholera and dysentery are examples of diarrhoea related diseases. Diarrhoea, cholera, dysentery, and typhoid are primarily water borne. Invariably, water borne and water related (malaria) diseases are responsible for 65% of prevalent sicknesses among the water users in the study area (Table 6-11).

That water borne or related diseases are responsible for most of the prevalent diseases in the study area is important. Apart from signifying the most prevalent diseases, the recorded percentage (65%) also infer that water sources are major sources of exposure to the identified prevalent sicknesses. The percentage is large enough and thus sufficient to inform the need for water safety plans of water sources in the area.

Table 6-11: Prevalent ailments among water users, N = 61, N^I = 55

SN	Diseases/ailments	Frequency	% Frequency
1	Malaria	23	42
2	Diarrhoea [a]	7	12
3	Typhoid	6	11
4	Body pain [b]	5	9
5	Fever	3	5
6	Cough	3	5
7	Skin infection	2	4
8	Headache	2	4
9	Pile	1	2
10	Jaundice	1	2
11	Cold	1	2
12	Boil	1	2

[a]: Diarrhoea and diarrhoea related diseases – cholera and dysentery; [b]: Generalised body pain includes stomach pain (1), leg pain (2), menstrual pain (1), and generalised pain (1)

Fifteen of 61 respondents explained what they understand has the cause of acknowledged ailments. From Table 6-12 about half (47%) the 15 respondents mentioned known causes of specified diseases while another 20% mentioned causes, which may be regarded as secondary or indirect causes of specified diseases. A third or about 30% of the respondents do not however know the cause of acknowledged diseases.

The resultant percentages as shown in Table 6-12 corroborate lack of disease know-how, one of the factors that influence sickness denial attitude exhibited by water users.

Table 6-12: Specified causes of diseases, N = 61, N^I = 15

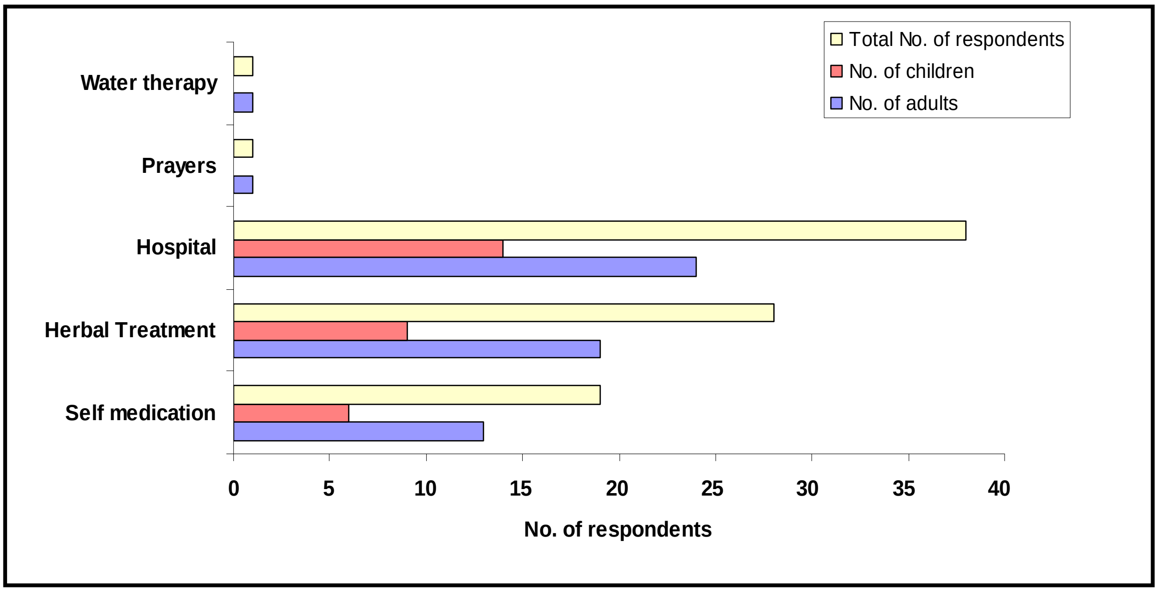
Diseases	Causes	No. of respondents (F)	% F
Malaria	Mosquito bites	5	33
	Stress	3	20
	Over-work	1	7*
	Dirty environment	1	7*
Diarrhoea	Change of water	1	7*
	Food	2	13
	Big navel	1	7*
Jaundice	Liver malfunction	1	7*

* Approximated %; Stress, over-work, and big navel are not related to known causes of specified diseases; Dirty environment and food may be regarded as secondary causes of specified ailments.

Types of treatment, treatment categories, and forms of medications

Five different forms of disease treatment are specified by 58 water users (Figure 6-7). Twenty nine of the 58 users described how their children are treated in sickness. As a result the total number of times (frequency) that forms of treatment is mentioned is 87 (Figure 6-7). The forms of treatment are, seeking medical care from orthodox hospital (38 of 87 or 41%), engaging in herbal or traditional form of treatment (28 of 87 or 33%), and varying forms of self medication (19 of 87 or 22%), water therapy (1 of 87 or 2%), and prayers (1 of 87 or 2%).

From Figure 6-7, while water therapy (deliberate water intake for disease treatment) and prayers are in the minority (4%), seeking care from the hospital, herbal treatment and self medication together formed the most (96%) preferred forms of disease treatment in the study area.



NB: Water therapy is deliberate water intake for disease treatment; N = 87

Figure 6-7: Forms of disease treatments

There are however six other different treatment categories described by the water users (Table 6-13). The number of times (total frequency) that the treatment categories are mentioned is 60. That is $N^{I} = 60$ (Table 6-13). The six treatment categories are centred on the three preferred forms of treatments presented in Figure 6-7. The categories are as a result of water users sticking with one form of treatment or using a combination of two or three forms of treatment. The first three categories are using only the hospital care (40%), herbal treatment (13%), or self medication (17%). The other three categories are combination of either hospital and herbal treatment (18%), self medication and herbal treatment (8%) or combination of all the three preferred forms of treatment – hospital care, herbal treatment and self medication (3%).

Table 6-13: Treatment categories

Treatment groupings	Frequency	% Frequency
Hospital treatment only	24	40
Hospital and herbal treatment	11	18[*, b]
Self prescription only	10	17[*, a]
Herbal treatment only	8	13[*, b]
Self prescription and herbal treatment	5	8[*, a, b]
Self prescription, herbal and hospital	2	3[*, a, b]
Total	60	100

[*] Approximated %; [a] Percentage exposure to self medication; [b] Percentage exposure to herbal treatment

Figure 6-8 split up the total frequency in treatment categories to reflect especially the adult and the children groupings. Hospital care remains the most used treatment category for both adult and children while treatments involving the combination of self medication, herbal and hospital care represent the least used type of care.

Also from Figure 6-8, 17 (or 28%) out of 60 respondents are exposed to self medication. Eleven (or 65%) of the 17 reported are adult while six (or 35%) of the described children treatment cases show children exposure to self medication. The 35% of the reported 17 cases do not reflect the number of children but signify the percentage of adult water users who described disease treatment for their children. The actual number of children beneath the 35%, though not quantified, may thus be substantial.

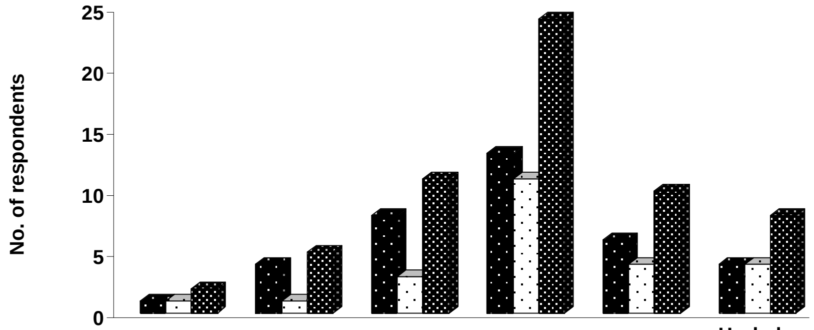
Self medication is managing ones own healthcare. Self prescription is a popular method of disease treatment. That an un-quantified, but probably substantial number of children are embedded in the percentage equally suggest that many children are also exposed to self (parents' prescribed) medication.

Unsupervised self medication can result in a number of health risks. The health risks may be due to misdiagnosis (similar symptoms leading to incorrect medication), unknown side effects, and/or excessive dosage to mention a few (Ebersole et al., 2004). That self medication as described by users in the study area is unsupervised is evident from users' statements. For instance while one female respondent (R53) claimed that '*'some people (drug hawkers) come here to sell us medicines'*, another (R37) claimed that '*it (Bonababe – a local brand of teething formula) was advertised on television*'. Apart from users' statements unsupervised self medication is also evident from the list of mentioned prescription sources (Table 6-14). From Table 6-14, seven (42%) of the 17 self medication cases are clearly from unsupervised sources.

Table 6-14: List of named sources of prescription/medication

Sources of medication	Frequency	% Frequency
Chemist *	4	23
Friends [a]	2	12
Long time usage [a]	2	12
Drug hawkers [a]	1	6
Television advert [a]	1	6
Repeat prescription	1	6
Not specified	6	35
Total	17	100

* Chemists are generally manned by un-trained medical or pharmaceutical practitioner;
[a] Apparent unsupervised prescription sources



	SP / Herbal / Hospital	SP & herbal	Hospital & herbal	Hospital only	SP only	Herbal treatment only
No. of adults	1	4	8	13	6	4
No. of children	1	1	3	11	4	4
Total No. of respondents	2	5	11	24	10	8

SP: Self prescription

Figure 6-8: Disease treatment category curve

It is also important to note the percentage of responses in favour of herbal treatment – 26 (or 42%) of 60 responses. Seventeen (or 65%) of the 26 responses represent adult exposure while nine (or 35%) represent children exposure to herbal treatment. Again it should be noted that the number of children within the 35%, though not quantified, may be substantial.

Herbal medicine is used in one of three instances; as first treatment, complementary treatment to hospital care or self medication, or as preventive medicine (Box 6-8). Going by the percentage of usage (42%), herbal medicine in the study area is common practice.

The cause for concern in herbal treatment is not necessarily in the common practice but the fact that the treatment is usually self-prescribed and from unregulated herbal market. According to the water users, the two main sources of herbal prescription in the study area are self/individual knowledge and/or herb sellers (Box 6-9).

First treatment

I:	*How do you take care of yourself when sick?*
R_{90}:	*First, I take herbal treatment, if this is not sufficient, then I go to the hospital.*

Complementary treatment

I:	*How did you treat the problem?*	*I:*	*How did you treat yourself?*
R_{81}:	*I treated it with anti-biotic and herbal medication for skin infection.*	*R_{87}:*	*I went to the hospital but I also use herbal treatment*

Preventive treatment

I:	*How do you treat yourself when sick?*	*I:*	*How do you treat yourself when sick?*
R_{84}:	*I don't normally fall sick. I use herbs to prevent malarial and pile.*	*R_{86}:*	*Herbs. I don't wait for sickness so I treat myself in advance*

Source: Research interviews; I: Interviewer; R: Respondents

Box 6-8: Three ways of using herbal treatment

Herb seller prescription

I:	*Who prescribed the herbs for you?*
R_{55}:	*I have people at Itoku herb market who selected the herbs for me*
I:	*Are you the one that told them what is wrong with you then they prescribed for you different sorts or what?*
R_{55}:	*Fever herb is an ancient one it has no variance we know what to use.*

I:	*Who prescribes the herbs for you?*
R_{56}:	*We have customer (an herb seller who they frequently patronized) and we take the children there*
I:	*Do you tell the herb seller what you want or he just prescribes for you?*
R_{56}:	*We take the children to him so he knows what to do*

Self prescription

I:	*We asked your son what you do when he falls sick, what do you use?*
R_{68}:	*Herbal medicines*
I:	*How do you know the type of herbs to make?*
R_{68}:	*As long as we can get the leaves*
I:	*Do you know the leaves to get?*
R_{68}:	*Yes*
I:	*How do you know, did you train for it or what?*
R_{68}:	*We were brought up with it*
I:	*So what type of leaves do you get?*
R_{68}:	*We got malaria fever herbs*
I:	*How many days do you need to use the herbs before it goes?*
R_{68}:	*If it is only the leaves, it takes 2 to 3 days but if we include 'itakun' (the stem), it takes about 5 days*
I:	*What is 'Itakun'?*
R_{68}:	*That is the branch of the herb tree*

Source: Research interviews; I: Interviewer; R: Respondents

Box 6-9: Herbal treatment prescription sources

Apart from afore mentioned health risks involved in self prescription, there are other potential dangers of herbal remedies. Potential dangers of herbal remedy include among others the problem of active compounds, dubious safety (natural does not mean safe), or interference with prescribed drugs (Jackson et al., 2004). Interference of herbal treatment with prescribed drugs for instance is particularly important because 13 (or 50%) of 26 responses involved in herbal treatment complement herbal medicine with hospital care (Table 6-13 and Figure 6-8). Interference with prescribed drugs is important as drug interference could be lethal (Jackson et al., 2004).

Self prescription is reported in Natural Therapy (2009) to play a role in the management of minor illnesses. Herbal medicine also occupies a useful place in disease treatment. The best practice in medical treatment is however to ask a health professional[34] for advice and procure prescription from regulated outlets. The best practice thus suggests the need for regulated market of either the orthodox or traditional medicines.

Figure 6-8 again shows that:

- The majority (40%) of water users attach and seek disease care with and from orthodox medical practices in hospitals (that is hospital care represents the most commonly used of the treatment categories)
- Some (18%) users complement hospital care with traditional or herbal treatment
- Some (17%) users engage in self medication
- A very small number (3%) of users complement hospital care with herbal treatment and follow on with repeat prescription
- While another small number (8%) complement self medication with herbal treatment without consultation and advice from medical practitioner or hospital.

The highlighted variation in percentages is informed by the perceived degree of seriousness to disease. The variation in percentages also describes disease treatment journey. When the disease is very serious, it takes a hospital care to cure/fix the problem. If the sickness is however perceived as minor, then water users start with self medication. If symptoms persist, users add herbal treatment and eventually users end up in the hospital if the first two self attempts fail. After the hospital care, users continue with either repeat prescription of hospital medication or stay on herbal treatment to prevent sickness reoccurrence. The dialogues in Box 6-10 give insight into the described treatment journey.

[34] Health professional may be a medical doctor, pharmacist or complementary health practitioner like nurses

I:	*How do you know that it is Fansidar you should use?*
R_1:	*That's what I have been using for them*
I:	*What about if he has a different sickness*
R_1:	*If I don't see changes I will take him for blood test and if he has typhoid I will take him back to hospital and when they in the hospital see the result they know what to give.*
I:	*How do you take care of yourself when sick?*
R_{90}:	*First, I take herbal treatment, if this is not sufficient, then I go to the hospital.*
I:	*How did you treat them (the children)?*
R_{90}:	*Herbs: I use herbs to clear the tongue*
I:	*Can you explain that?*
R_{90}:	*Blackness of the tongue is a symptom of malaria. Once you use herbs to clear the tongue, the patient will be able to eat and feel better. If not, they go to the hospital*
I:	*How do you treat yourself when sick?*
R_{95}:	*I don't get sick. If at all, I do self medication if it is headache. If the headache continues or leads to vomit, tiredness or fever, these are big ones so I go to the hospital.*

Source: Research interviews; I: Interviewer; R: Respondents

Box 6-10: Disease treatment journey

Four main types of medications are identified from 43 (N^I) responses (Figure 6-9). The medications in order of usage are drugs (27 or 63%), herbs (13 or 30%), injections (2 or 5%), and water (1 or 2%). Figure 6-9 also shows that the usage of herbs as medication in children is about 40% (5 out of 13) of total herb usage. In terms of the number of users however, the ratio of drug usage in adult and children is almost 1:1 (Figure 6-9).

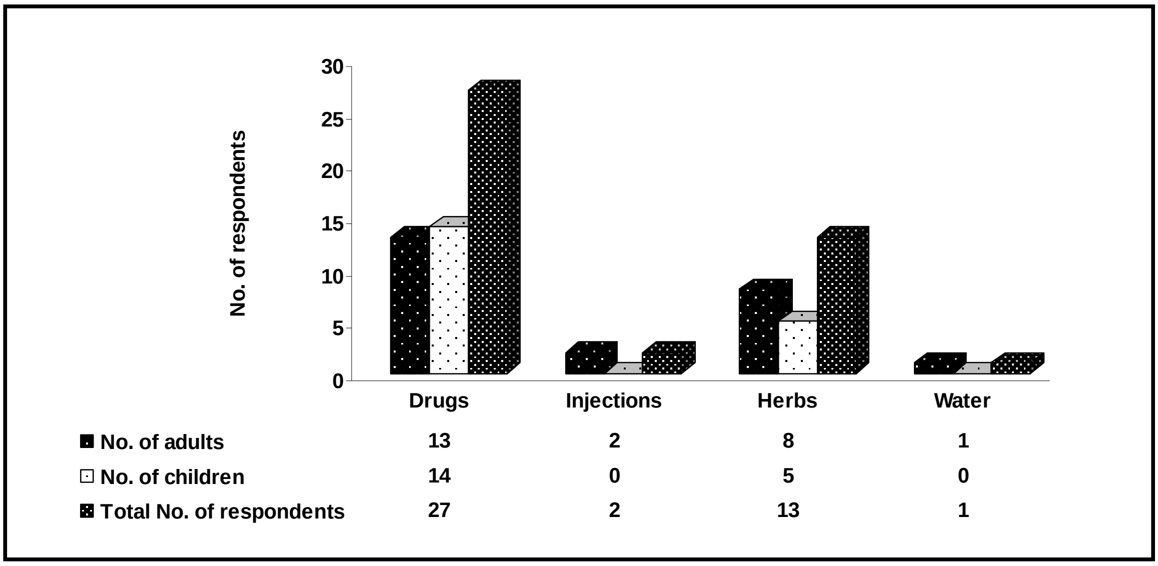


Figure 6-9: Types of medications

Conclusions – Perceptions of health impact and implications for water safety plans

It is apparent from the results presented in this section that the perception of water users in relation to health impact is important. Users' perception of health impact can undermine the adoption and implementation of water safety plans.

Disease misrepresentation and lack of disease know-how by users are clear indications of how adoption of water safety plans can be marred. Religious belief that masks the role of man in disease prevention is another example of how the adoption of water safety plans may be compromised. And, denial of health impact by users translates to denying the need for water safety plans.

Water safety plans represent the role of man in disease prevention and health sustainability. Water safety plans are expected to impact on health if adopted and implemented (WHO, 2004a). To impact on health, facilitating water safety plans would require clear understanding of users' perceptions of health impact and the factors influencing those perceptions.

Besides training users on the basic knowledge and skills surrounding water safety plans of their sources, some of the action points for water safety plans facilitators would include among others:

- Understand users' perceptions of health impact. Denial attitude to health impact is denying the need for water safety plans
- Address the factors affecting attitude of users to health impact through initial supporting programs.
- Identify key stakeholders to involve in initial supporting programs. Examples of key stakeholders include religious leaders, public health educators, and/or health practitioners.

Initial supporting programs should include enlightenment and education on the following: role of God and man in disease prevention; water borne/related diseases, causes and route of transmission; best practice in disease treatment; and identification of regulated medical prescription sources.

6.2.4 Attitude to water safety

As reported in 4.6.2, it was important to engage water users in an on-going conversational interview due to the need for repeat water quality analysis of sample points. During the water quality analysis exercise, feedback on previous water quality status was given in order to assess the attitudes of users to the safety of their source water. Water users were asked if they knew the cause and/or prevention of especially the presence of faecal bacteria in their source water.

The attitude of users to water safety is deduced from the responses of 29 users. Users exhibit seven knowledge levels, which reveal their attitude to water safety. As a result, users' attitude to water safety is not generalised. The knowledge level informs the attitude in each category. The seven knowledge levels are discussed in turn.

A. Seek advice on water safety measures

The reaction of nine (or 31%) of 29 users to the question of what is responsible for the water quality status is to seek advice on water safety measures. Two of the nine respondents (R39 & R55) sought to understand the cause of faecal bacteria in the water source. Seven of the nine users are interested in how to remove the germs by asking literally '*what can we do*' (Box 6-11)? More (7 out of 9) users thus take a reactive approach to water safety threats rather than a proactive attitude. Understanding the cause of water safety threats in source water may however be the first step in taking the initiative in water safety threats prevention. Primarily water safety plans involve both the preventive and reactive measures. However the underlining principle of water safety plans is taking proactive actions that prevents or minimises identified water safety threats in any water source.

The reactive attitude of users may be brought on because the interviewer is perceived knowledgeable in water quality; '*…you have checked with an instrument and discovered that there are germs in the water, you must be able to tell us what to do or advise*' (R2, Box 6-11). Arguably however, seeking to understand the cause of water threats (preventive/proactive attitude) or taking a reactive poise to water safety is a choice that is not necessarily influenced by being interviewed by an expert. Respondents made the choice of the knowledge route to seek with the expert. A reactive response to water safety problems exhibited by the seven of the nine users is found to be a common characteristic of developing country cultures (Jaeger and Kanungo, 1990).

R_2:	*You have checked it with an instrument and discovered that there is germ there. We don't see anything in it as we are looking now. But **if there is something to be done to remove the germs or if you have any advice, tell us**.*
I: *R_9:*	*what do you think can be done….?* ***It is what you think that we can do**. If the grace for such is available; it will make no meaning if we lock it up. It is from you that we can know what to do*
R_{15}:	*What I think is that **if you have anything to use for the water, you can give us** or if it is that we are going to buy we will*
I: *R_{22}:*	*We took water sample of this well in our first visit. The result shows that there are some disease-causing germs in the water.* ***What can we do to it now?***
R_{35}: *I:* *R_{35}:*	***What are the steps we can take now?*** *Well you are the one that owns it, so you should tell us what you think you can do* *No, we are together to enlighten ourselves.*
R_{39}: *I:* *R_{39}:*	*So it can cause illness like cholera?* *With what we found from the test, yes* ***What is the cause of such germs and what can we do**?*
R_{46}: *R_{47}:*	*She said the water has cholera and she is asking us what we can do.* ***You can tell us what to do***
I: *R_{55}:* *I:*	*We found cholera causing germs in your water* ***What is the cause of that?*** *Exactly what I came to ask you……*

Source: Research interviews; I: Interviewer; R: Respondents

Box 6-11: Users seek advice on water safety measures

B. Identification of threats to water safety

Six of 29 (or 21%) users identified three water safety threats to their sources. The three identified water safety threats are unhygienic handling/multiple buckets, un-covered well, and flooding of hand dug wells.

The first threat (bucket related) is mentioned by three (R1, R31, & R32) of six users who identified water safety threats. In the users' words '*maybe we should tell the children that are fetching the water not to put their bucket on the floor or bare ground again'* (R1); '*Maybe because we don't cover it or the buckets that we put into it'* (R31); and '*We don't cover it and people are using different bucket to draw water from the well*" (R32).

As shown in section 6.1.2, hand dug well water is commonly drawn with bucket and rope. From the users' words unhygienic handling of bucket and rope involves where the bucket and rope is kept before and after usage, and the state of cleanliness of the bucket and rope. The use of multiple buckets brought in by multiple users for use in one hand dug well from hygienically un-ascertained sources is also tied with the bucket related water safety threat.

While uncovered hand dug well is acknowledged by two of the first three (R31 and R32) users cited above, flooding of hand dug well is mentioned by three (R35, R49, & R75) of the six users (Box 6-12). Flooding refers to the influence of rainfall on un-cemented well head area (R49) and water turbidity (R35 and R75).

In effect, the following water safety threats are inferred:

- Unhygienic handling of bucket and rope (well operation); R1 and R31
- Usage of multiple buckets (well operation); R32
- Un-cemented/un-kept well head area (well structure); R49
- Turbidity in hand dug well water (water quality); R35 and R75
- Uncovered well (well structure); R31 and R32

The listed water safety threats can be summarised into three major water safety threat headings, namely threats due to:

- Well operation
- Well structure, and their influence on
- Water quality

The highlighted water safety threat headings inferred from users' responses are similar to the water safety threat categories derived from the research risk assessment of hand dug wells (7.3.1). The water safety threats groupings are by implication crucial to water safety plans as they signify critical aspects of hand dug wells to target water safety interventions.

Users' identification of water safety threats opens the way for users' identification of water safety measures. In the words of R1 shown above, the needed water safety measure (*'…not to put their drawer on the floor…')* is embedded in the recognition of the water safety threat. Water users' identification of threats to water safety is therefore fundamental to successful water safety planning.

R_{35}:	*My opinion is that when rain falls, erosion might enter into the well*

R_{49}:	*'….it is my thinking that rain makes the place muddy*

R_{75}:	*The problem with the well is that erosion enters it (the well) during the raining season.*
I:	*How do you know that erosion enters the well?*
R_{75}:	*After any heavy rainfall the water turns into a brownish colour.*
I:	*Do you know whether the ring lining extends to the base/bottom of the well?*
R_{75}:	*Yes, what people say is that the well water turns brown whenever it rains because our house is at the bottom of the slope but it is very white and clean during the dry season*

Source: Research interviews; I: Interviewer; R: Respondents

Box 6-12: Flooding (erosion) of hand dug wells; identified water safety threat

C. Lack of water safety knowledge

Five of 29 respondents expressed a lack of knowledge about water safety. The expressed lack of knowledge is in terms of the cause of water threats (R11, R30) and in terms of what to do about the threats; *'I don't know what we can do about it (E. coli in water)…'* (R1, R11 & R23; Box 6-13)

As shown in Box 6-13, two of the five users claimed no knowledge of the cause of water threat (Group I), and three of the five users claimed no knowledge of the corrective measures to take (Group II). While the two groups both represent the 'no knowledge' level, the difference in the 'no knowledge' route between the two groups is acknowledged. Group II expressed no knowledge in solving the water threat problem – a reactive approach – while Group I claimed no knowledge of the causes.

That three of the five users are in Group II can be seen to further corroborate reactive response of users to water safety issues. Water users tend to be more concerned with the knowledge (or lack of knowledge) of how to respond to water problems than understanding the cause. Understanding the root cause of water threat should however be seen as the first step in corrective measures and the proactive approach to water safety plans.

The statement by R30, *'Well I don't know, people that come to draw water come with clean buckets'* gives insight into what might be responsible for the expressed lack of knowledge by users. The statement suggests that usage of unclean bucket invariably unhygienic well operation is linked with water threat. The statement however also suggests that users are not aware of other pathways by which water threats can get into water sources. The expressed lack of knowledge by the users thus suggests the need for education and enlightenment on water pollution threats, transmission routes, and water safety measures for household water sources.

Group I

I:	*Are you saying you do not know the causes or do not know the corrective steps to take?*
R^*_{11}:	*Yes (implying no)*

I:	*Since you live here I want to ask you, what could be responsible for the concern (E. coli in water)?*
R_{30}:	*Well I don't know, people that come to draw water come with clean buckets*

Group II

I:	*Now that the water has germs what do you think you can do to make the water safe?*
R_1:	*Is it to this well?*
I:	*Yes, to make the well safe for use*
R_1:	*We don't know what can be done…….*

I:	*Are you saying you do not know the causes or do not know the corrective steps to take?*
R^*_{11}:	*Yes (implying no)*

I:	*What do you think can be done?*
R_{23}:	*What can we do?*
I:	*You own and use the well you should be able to say?*
R_{23}:	*I don't know what we can do about it*

Source: Research interviews; I: Interviewer; R: Respondents; *: The response of the respondent is relevant to both groups

Box 6-13: Users expressed lack of knowledge on water safety

D. Water sources should be treated

There are five respondents in Knowledge level D. The five respondents recognized and expressed the need for source water treatment. R34 argued that water safety measures targeted towards the provision of adequate source structure without source water treatment is not enough to ensure water safety (Box 6-14). R93 also opined that water from hand dug wells can be put to more usage and up-graded from non-ingested to ingested water uses if the wells are treated (Box 6-14). R46, R59 and R80 would prefer hand dug well water be treated at source, that is in the wells.

The position of the five respondents in Knowledge level D gives some cause for optimism and suggests opportunity for water safety plans sustainability and scale up. Sustainability as referred is defined in two ways. Firstly in terms of ease of adoption of water safety plans for hand dug wells as the users already saw the need for water safety measure – source water treatment. Secondly in terms of continuity in water safety plans implementation driven by users' preference in source water treatment. The opportunity for scale up is in terms of treating hand dug well water not only at point of use but also at source (holistic treatment).

I:	*How clean is the tap water?*
R_{34}:	*It is good, it comes from pipe, but I still boil the one that I want to use*
I:	*Why do you boil it?*
R_{34}:	*Because of diseases like cholera and for personal protection*
I:	*Where do you think the tap water comes from…..?*
R_{34}:	*It comes from the water board*
I:	*Where does water board get their water from?*
R_{34}:	*I don't know but I think they pump water from river or dam into the water board and give it good treatment*
I:	*Do you know how they treat it?*
R_{34}:	*I don't know how it is treated*
I:	*Are you the only one using the well?*
R_{34}:	*No, people come from outside to use it*
I:	*If I try to convert the well into a borehole will you use it?*
R_{34}:	*Yes*
I:	*What about if we change the cover and try to make it more hygienic?*
R_{34}:	*If you put a cover; are you going to pump out the water that is there or how are you going to do it? If you leave the water there and cover it without doing anything to it you will still get the same water*
R_{46}:	*She said the water has cholera and she is asking us what we can do….Can we put the chemical inside the well?*
R_{59}:	*It would have been better if we can pour it (water guard) inside the well*
R_{80}:	*Can we apply it directly to the well?*
R_{93}:	*If the well water is treated with water guard, I can use it for cooking and bathing….*

Source: Research interviews; I: Interviewer; R: Respondents

Box 6-14: Recognition of source water treatment by users

E. Non-identification of water problems

Four of the 29 respondents could not identify or '*see anything wrong*' with their source water. The statements of the four respondents reveal that (Box 6-15):

- Water clarity is an indication of good water – turbid water is poor water, clear water is good water R7
- Water quality is not a concern if the water is for non-ingested uses R8
- Some water safety measures have been taken that should be ok R19
- Admitted the occurrence of a water threat causing event but the problem was sorted so the water is fine R19
- Never been infected with cholera, so the water must be fine R71
- There is always a crowd of people on the well so the water must be good R71

I:	*The test revealed that germs are there but you are the users so you should be able to tell us what you think is responsible for such.*
R_7:	*Everything is for use to us we don't even see any germs or anything wrong with the water.*
R_8:	*It is just for cloth washing and plate washing*
I:	*That is why we came again and to ask you of how you have been using the well that resulted in such a state.*
R_{19}:	*I don't see anything beyond how we are using it because firstly we are covering it, secondly one day when a goat enters into it, we removed all the water and now that you said you discover things, it surprise us.*
I:	*We found E. coli; one of the germs that can cause cholera in the water. Since you are the one using the well I want to ask what you think may cause this in your water.*
R_{71}:	*This is the water we have been using. It is the water that I drink and use. And I have never been affected by cholera or anything*
I:	*What about other users?*
R_{71}:	*There is always a crowd of people on this well. In the morning and once the students are out from school. Many students usually come here to drink water to cool off from fatigue before heading home. The water is good and had been good water source*

Source: Research interviews; I: Interviewer; R: Respondents

Box 6-15: 'All correct' attitude to water safety

The listed deductions from the statements of the four respondents help to understand why users do not see anything wrong with their water. The deductions highlight users' criteria or indicators for good water on one hand (points 1, V and VI; Group I):

- Water clarity
- Large number of users
- Long term usage of water without infection with water disease.

On the other hand the deductions feature user-perceived water safety conditions (points II, III, and IV; Group II):

- A one-off water measure ensures source water safety
- Limited water safety measure is adequate
- Water quality not a concern if water is for non-ingested uses

Consequently two groups of users emerge. The first group '*see nothing wrong*' with water once indicators or criteria for good water are met. For the other group, nothing is wrong with water so long as the perceived water safety conditions are in place. For either group therefore the water is good or 'all correct' so long as some criteria or conditions are met. The stance taken by the users in these two groups is here referred to as 'all correct' attitude.

Beneath an 'all correct' attitude are indicators for good water and perceived water safety conditions that are not necessarily consistent with water safety. For instance from the highlighted indicators, clear water though good does not mean safe water. Long term usage without infection with water disease may mean immunity. Immunity to water disease due to long term usage does not imply the water is safe for use for new users. Usage of source water by large number of people also does not imply the water is safe for use. Likewise from the perceived water safety conditions, a one-off water safety measure will not be enough to ensure water safety of a source. Limited water safety plans will also not be adequate. Water quality also should always be of concern especially household water quality.

Although the line of influence of the indicators to good water is debatable, the type of impact the user perceived water safety conditions will have on water safety is clearly negative. Invariably, the consequence of an 'all correct' attitude to water safety informed by either preset criteria or conditions may be regarded as negative or unfavourable. Preset water user criteria for good water or water safety conditions thus need to be aligned with established water safety guidelines.

Water users who do not see anything wrong with their water may find it difficult to see the need to take informed water safety measures. There is therefore the need to identify correctly through research two important issues. Firstly, identify the attitude of water users to water safety and secondly identify the basis or factors, which inform the attitude so as to target enlightenment and training appropriately.

F. Water problem identification with corrective actions

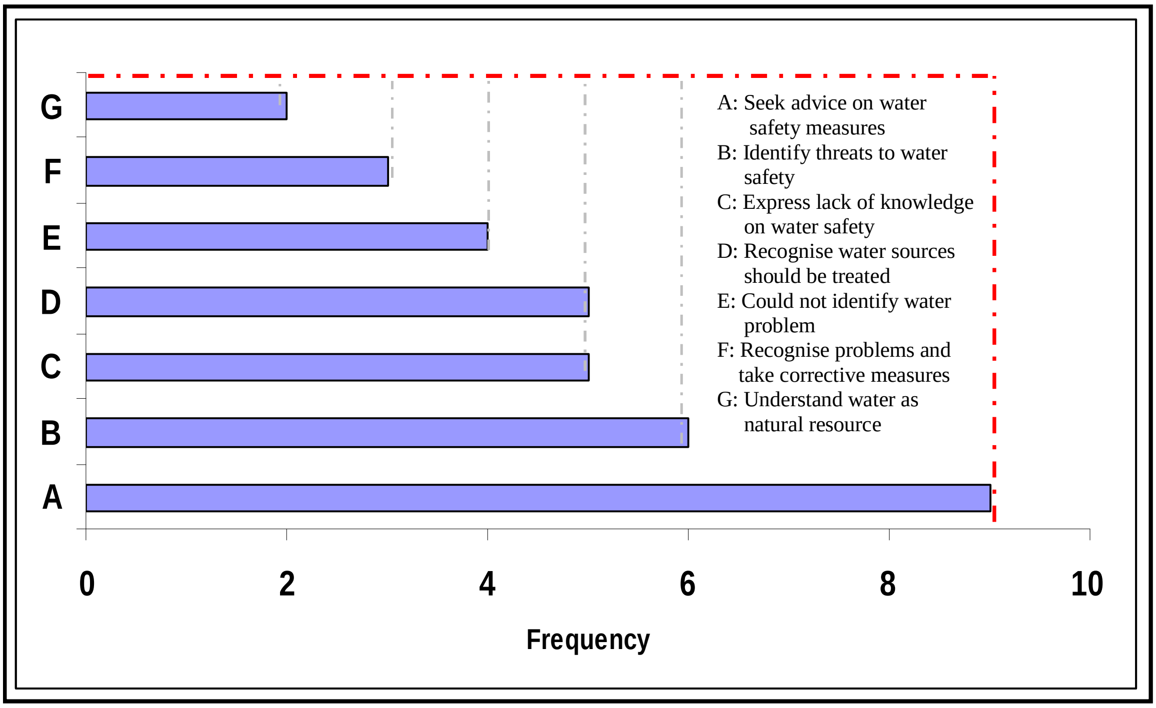
Three of the 29 respondents were able to recognize water problems and took corrective measures. Table 6-15 details the identified problems and the corrective actions taken by the respondents.

Table 6-15: Corrective actions to identified water problems

Identified water problems	Corrective measures	Respondents
Dirty water	Treat with Water Guard*	R16
Water borne diseases	Treat water by boiling	R34
Noticed disease carrier in source water	Use disinfectant at point of use	R81

* Water Guard is brand name for chlorine packaged as hypochlorite for household water treatment

That water users are able to spot problems and threats to water and human health safety and follow on with a corrective measure is an act that reiterates optimism for water safety development and management. The concern however is the percentage of users who are careful to spot problems and take corrective actions are barely 10% of the 29 users. The percentage represents a minority group relative to the percentage of users with especially reactive attitude to water safety (Figure 6-10).



NB: Area of influence of reactive attitude is set within red lines/box; N = 29

Figure 6-10: Area of influence of reactive attitude to water safety

The comments from the three respondents indicate that the users are safety conscious (Box 6-16). Two of the three respondents became safety conscious after observing in one instance dirt in water (R16) and the other instance insect in water (R81). The third respondent gave personal protection as the drive behind safety consciousness (R34). The lessons learnt are that vigilance of the state of water at source or point of use coupled with the need for personal health protection is fundamental to safety alertness. It is safety alertness/consciousness that drives water safety actions.

R_{16}:	*The tap water sometimes is also dirty that is why we bought and use water guard*
R_{34}:	*It is good, it comes from pipe, but I still boil the one that I want to use*
I:	*Why do you boil it?*
R_{34}:	*Because of diseases like cholera and for personal protection*
I:	*Have you ever had any problem with the well?*
R_{81}:	*Yes, when I was using the well water to bath, I saw some insects in the water so I stopped using the water to bath. The insects that I saw must not touch your skin. Once they do, they enter into the body to cause skin infection called 'jomi-jomi'* *(see following responses)*
I:	*Can you explain that?*
R_{81}:	*It looks like mosquito bites or boil all over the body.*
I:	*How did you treat the problem?*
R_{81}:	*I treated it with anti-biotic and herbal medication for skin infection.*
I:	*How long did it take to resolve that problem?*
R_{81}:	*It spanned about 2months before it cleared and since then, I use disinfectant with the water before use.*

Source: Research interviews; I: Interviewer; R: Respondents

Box 6-16: Health safety consciousness in users

G. Water as natural resource

The second minority group, 2 of 29 respondents saw water as a natural resource. Conventionally water is a natural resource. To this minority group however, water is a natural resource and hence they are not responsible for water quality status (Box 6-17). The argument of the two respondents is that water springs from the ground (R11) and water is from God (R49). As such the Supreme water provider and the state of water abode should be held liable for water quality status. The views held by users in this group show that the role or influence of users in relation to water quality is not understood and responsibility to water safety is shifted.

I:	*The first question is what are the likely causes of germs in your well water?*
R_{11}:	*It is not that we poured the water in there; it is springing from the ground*
I:	*what do you think are the causes of this level of contamination?*
R_{49}:	*I am not sure. I know that water is from God ….*

Source: Research interviews; I: Interviewer; R: Respondents

Box 6-17: Water is a natural resource hence users not responsible for its safety

The highlighted seven knowledge levels are presented in Figure 6-10 to show the area of influence covered by each knowledge levels. The following are observed:

- Knowledge level A have a wider area of impact than any other knowledge levels (area depicted under red lines/box in Figure 6-10)
- Individual area of influence of knowledge levels B to G are embedded or set within the area of impact of knowledge level A

The two observations are expected. The number of users in knowledge level A accounts for more than 30% (9 out of 29 users) and more in number than any other knowledge groups. However the observed area of impact implies that reactive response or attitude to water safety threats exhibited by seven of the nine users in knowledge level A may be generalised. In other words, aside other attitude to water safety displayed by users based on their knowledge levels, water users generally have a reactive attitude to water safety.

In conclusion, the attitude that water users show to water safety differs and varies from reactive to ‘all correct’ attitude but the prevalent attitude is reactive. Beneath the exhibited attitudes are differing knowledge levels. Understanding and exploring the identified knowledge levels highlights the knowledge areas where appropriate training and enlightenment should be targeted for effective water safety development and management. The need for proactive water safety approach is also emphasized.

The perception of water users to water quality is not easily linked with perception of health impacts. Water users are clear in their perception that hand dug well water quality is compromised/poor but the users are also generally in denial of the health risks associated with poor water quality. Between perception of water quality and perception of health impacts therefore is a gap that is bridged by varied attitude dictated by varied knowledge levels to water safety. On one hand for instance, the most referred reason for non-drinking of hand dug well water relates to concerns for source and health safety. On the other hand however, one of the identified preset water safety conditions is that water quality is not a concern if water is for non-ingested uses. Such a preset condition reveals the thinking beneath denial and why poor water quality is not generally associated with health risks. The need to understand the mindset of water users on issues of source and water safety in order to align their perceptions with established water safety guidelines therefore can not be overemphasised. The need for adequate education on water safety issues is also stressed.

6.3 Summary

Chapter 6 presented results of the first research objective. The chapter described self supply water systems; primarily hand dug wells in Abeokuta, Nigeria. The description highlights the inventory, physical components, and the three main classifications of hand dug wells. The number of users per well was also estimated. Beside the description of the physical attributes of the wells, the attitude of water users was explored to know and understand the possible impact on water safety interventions. The next chapter focuses on the assessment of water quality status of hand dug wells in Abeokuta, Nigeria.

7 HAZARDS IDENTIFICATION: WATER QUALITY, SANITARY SURVEYS AND ANALYSIS OF RISKS

Investigating the water quality of hand dug wells formed a major part of the systems' hazard identification. The investigation was coupled with complementary sanitary surveys of the wells. Interrogation of the water quality and sanitary survey data generated a variety of findings. Some of the findings represent expected outcomes, and some were unexpected. Major outcomes are presented and discussed under the water quality results (7.1), the sanitary inspection results (7.2), the analysis of risk (7.3), and risk characterisations (7.4). The chapter ends with a highlight of key conclusions in the chapter summary (7.5).

7.1 Water Quality Results – General Results and Averages

Descriptive statistics including sample size, mean, standard deviation, minimum and maximum of the biological and physiochemical parameters investigated are shown in Table 7-1. All the samples show microbial contamination in excess of 100 cfu/100ml and 17% indicated the presence of *clostridium perfringens*. Apart from turbidity and conductivity, less than 40% of samples showed physiochemical values that are lower than maximum accepted concentrations recommended by both the National and WHO guidelines for drinking-water quality (WHO, 2004a; SON, 2007). These result present an overall picture of the poor state of self supply hand dug well water quality in the study area. The microbial parameters results particularly show that water from the self supply wells in the study area is not safe for consumption.

Table 7-1: Physiochemical and biological water quality parameters for self supply hand dug wells in Abeokuta, Nigeria; N = 100 water samples; 25 wells; April – July 2007

Parameters	Max limits [a]	N < ML [b]	Mean	Standard Deviation	Min.	Max.
pH (pH units)	6.5 – 8.5	34	7	0.56	5.5	8.5
Temperature (°C)	Ambient		29	1.1	25.9	32.3
Turbidity (NTU)	5	71	30	81.8	5	500
Nitrate-NO_3 (mg/l)	50	36	88	135	0.4	1,312
Electrical conductivity (µs/cm)	1000	67	797	391	120	1,753
TTC (cfu/100ml)	0	0	902[c]	1,328	100	8,000
Total coliform (cfu/100ml)	0	0	57,340 [c]	179,766	200	1,600k
Number of Detects *Clostridium perfringens*	0	Positive	17			
		Negative	83			

[a] Maximum limit based on National (Nigeria) and WHO drinking-water quality standards; [b] Number of samples below maximum permissible limits; [c] Geometric mean; TTC: Thermo tolerant coliform; NB: The National and the WHO standards are the same for listed parameters

7.1.1 Water quality status of alternative drinking water sources

Table 7-2 presents the water quality status from the four alternative drinking water sources identified in the study area. Table 7-2 shows the values of water quality parameters from seven public tap stands, average values of six different brands of 'pure water', results of one borehole water point and one public hand pumped deep well.

The physiochemical water quality status of the four alternative drinking water sources (Table 7-2) are generally within acceptable water quality limits (Table 7-1). The bacteriological results are however not within prescribed limits. The total coliform counts are well in excess of the 0 cfu100 ml $^{-1}$ for all the alternative water sources. The TTC counts are also very well above 0 cfu100 ml $^{-1}$ for tap water and 'Pure water'. Zero cfu100 ml $^{-1}$ is the acceptable limit for bacteriological counts in drinking water sources. Faecal contamination is not detected in borehole and the public hand pumped deep well but *clostridium perfringens* is detected at least once in each of the alternative sources.

The results in Table 7-2 suggest that the water quality of the available alternative drinking water sources in Abeokuta, Nigeria is better in terms of the physical and chemical water content than self supply hand dug wells. The alternative sources are however not safe for drinking based on the WHO guidelines. Table 7-2 suggests that borehole and the public hand pumped deep wells are better sources than public tap water and 'Pure water'. The evidence being the absence of thermotolerant coliforms from the borehole and the hand pumped deep well.

The water quality evidence provided by Table 7-2 confirms that water safety intervention is a must for all the available drinking water sources in Abeokuta, Nigeria. As there are no safe drinking water sources in the area.

Table 7-2: Average values of water quality parameters for alternative drinking water sources in Abeokuta, Nigeria

	Tap water[a]	'Pure water'[b]	Borehole	Hand pumped deep well
Temperature (^{o}C)	28.1	27.7	27.4	27.8
pH	7.2	7.2	6.9	6.4
Turbidity (NTU)	< 5	< 5	< 5	< 5
Electrical conductivity, EC (µs/cm)	146	142	267	217
Nitrates–NO_3 (mg/l)	5.1	4.5	12.6	7.2
Total coliform counts (cfu/100ml)	10,919[c]	602[c]	2,500	13,000
Thermo tolerant coliform counts (cfu/100ml)	417	267	AB	AB
Number of Detects of *Clostridium perfringens*: Positive	4	4	1	1
Negative	3	2	-	-

[a] Average from 7 tap stands; [b] Water in sealed sachet for sale as drinking water – average from 6 brands; [c] Geometric mean; AB: Absent; -: No detection

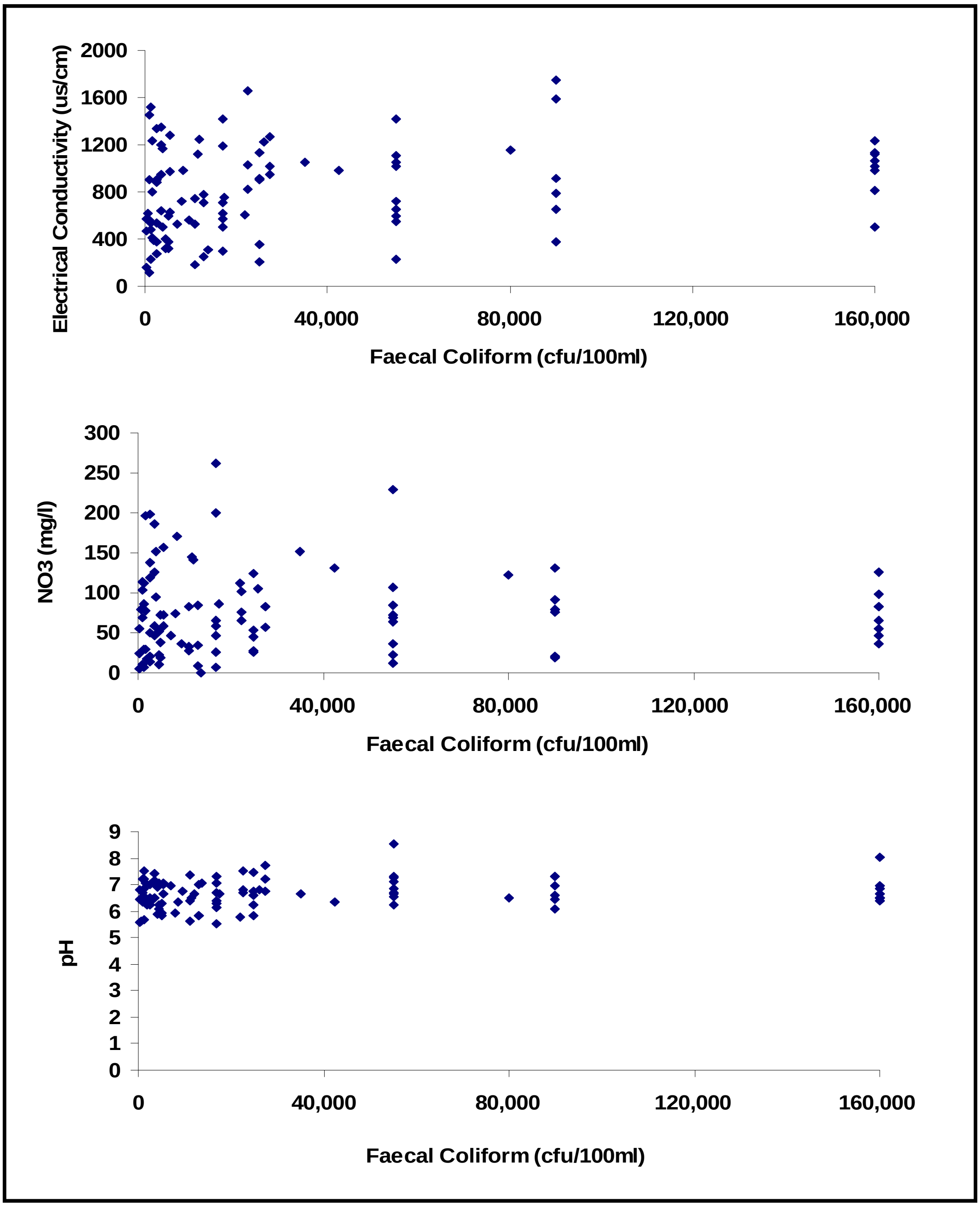
7.1.2 Faecal coliforms, Nitrates-NO_3, electrical conductivity, and pH

The safety of a water source is verified by testing for the presence of microbial parameters, usually those of faecal origin. The introduction of faecal contamination like sewage may however equally cause significant changes in the chemical quality of groundwater. Examples of expected changes include lowering of pH, and increase in electrical conductivity, EC (Barrett et al., 2000a). Nitrate is also frequently used as a marker of sewage input because it is derived from the microbial oxidation of excreted ammonia in soils, and is generally conserved in groundwater (Schmoll et al., 2006). High nitrate contents in groundwater thus depict contamination from poor sanitary activities or other sources like agricultural activities (Jacinthe et al., 2000). Agricultural activity is however not prevalent in the study area.

From Table 7-1, the failure rates recorded across the water samples for pH, electrical conductivity, nitrate-NO_3, and the microbial parameters, TC and TTC, vary. Samples that failed are those with > 0 cfu100 ml^{-1} of TC or TTC and/or above the given statutory limits (Table 7-1). For instance, the failure rate for electrical conductivity is 33%, pH is 66%, and nitrate-NO_3 is 67%, while a 100% failure rates are recorded for TC and TTC.

The failure rates of the chemical components, which are particularly high for pH and nitrate-NO_3 may be due to the influence of faecal contaminations of the water samples indicated by 100% failure rate for TC and TTC (Table 7-1). Table 7-1 also shows that high faecal contamination levels are recorded for the water samples. TTC counts range from 100 to 8,000 cfu100 ml^{-1} and the range of TC concentration is from 200 to 1.6 million cfu100 ml^{-1}.

The influence of high faecal contaminations on the chemical content of hand dug well water samples is however inconclusive. For instance, there is no apparent relationship between TC and either EC, pH or nitrate-NO_3 (Figure 7-1). However, it is possible that the unexpected results of TC and nitrate-NO_3 may be associated with other factors. For example, nitrate-NO_3 content in groundwater is also influenced by the redox conditions of the aquifer and not only by the presence or absence of contaminations (McLarin et al., 1999). The absence of association between TC, EC and pH in this study is however not understood.



N = 100; R^2 = 0.09 for FC / EC; R^2 = 0.03 for FC / pH graph; NB: N = 98, R^2 = 0 for FC / NO_3 graph

Figure 7-1: Influence of faecal coliforms on pH, EC (µs/cm), and nitrate-NO_3 (mg/l) of self supply hand dug wells, Abeokuta, Nigeria

Generally groundwater sources are regarded as a relatively microbiologically safe source of drinking water to surface water. The failure rates of the chemical contents and the wide value range of faecal coliforms in the water samples as shown above indicates that the notion of safety attached to ground water sources does not hold true in the study area.

Similarly, self supply systems serve millions of people especially in developing countries at both rural and urban centres. In the push for self supply systems to be recognized as important household water services, the focus has generally been limited mainly to issues of access, quantity, affordability (cost) and simple technology. Evidence as shown with the above results suggest, among others that:

- There is the need to include and target water quality in the general consideration of self supply sources.
- The need for usage of household level water treatment with any self supply systems.
- Calls for urgent water safety intervention.

7.1.3 Influence of rainfall on hand dug well water quality

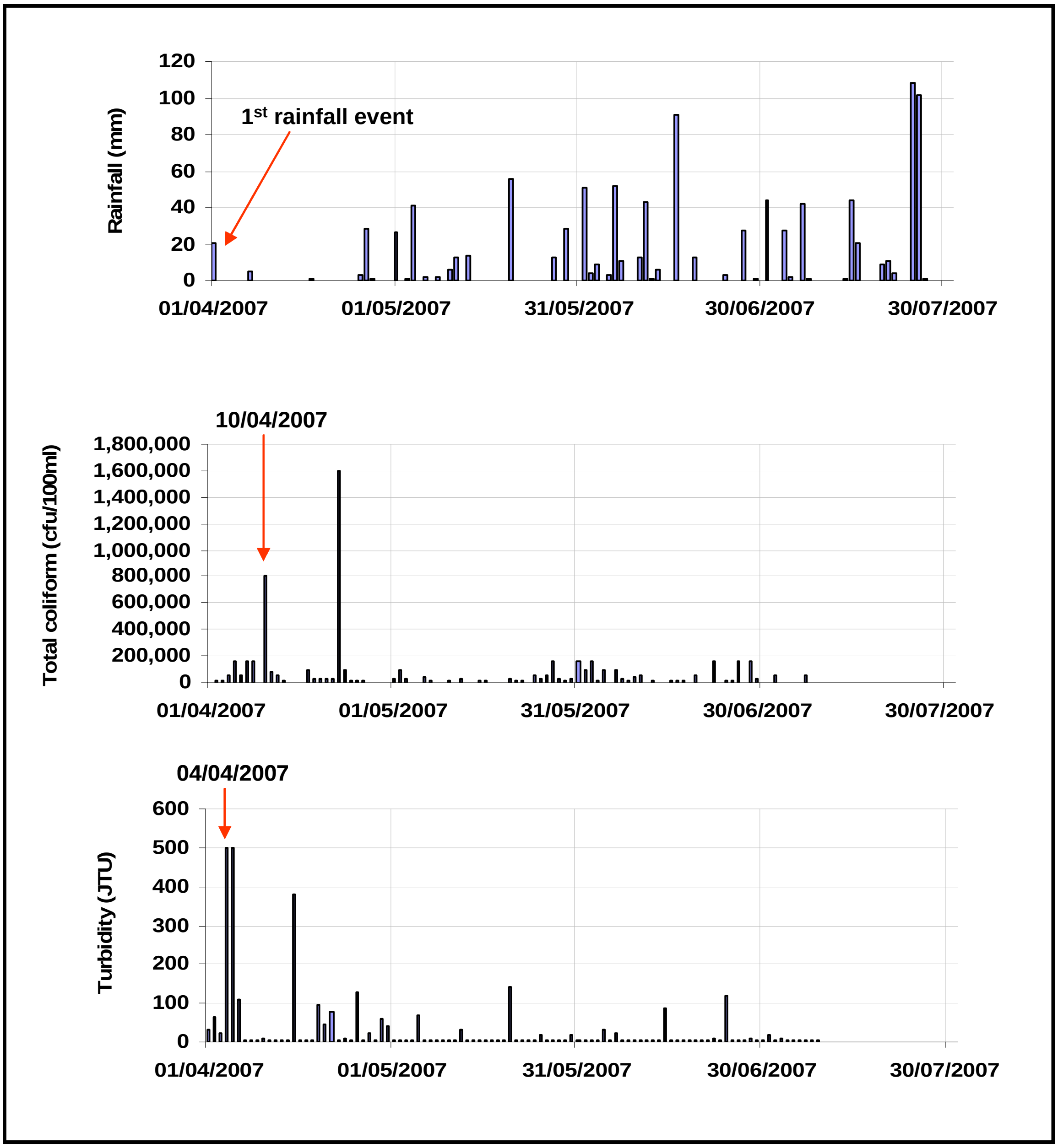
The concentration and distribution of faecal coliforms and pathogens in groundwater sources are not static but demonstrate temporal and spatial fluctuations. The variations are usually subject to seasonal changes in land use and changing weather patterns (Schmoll et al., 2006; Wright, 1986). Changes in land use and especially rainfall patterns equally generally influence other water qualities like turbidity.

Figure 7-2 shows the influence of rainfall on turbidity and TC contents of the self supply hand dug wells in the study area. In Figure 7-2, the first TC peak (10/04/2007) and first turbidity peak (04/04/2007) occurred between four to 10 days after the first rainfall event (01/04/2007). This indicates a possible cause and effect relationship between rainfall and reduced water quality of the wells. Maximum faecal contamination of well water in terms of both the number of wells and the level of contamination are recorded following the onset of rains. Faecal coliforms are found at one time or the other in all the wells during the sampling months of April to July 2007. The faecal coliforms are detected in 92% of the wells at the onset of rains in the month of April but reduced to 64% in July. The high percentage may represent the ‘first flush’ of pollution into the wells from surrounding land. C*lostridium* was detected in 4% of the wells at the start of rains but by the peak of rains in July, clostridium was detected in 40% of the wells. The percentages show that occurrence of faecal coliforms reduces with increase in rainfall events possibly due to dilution. The occurrence of c*lostridium perfringens* however increases with increase in rainfall events. *Clostridium* can survive for extended period of time after initial contamination by producing spores (Schmoll et al., 2006). The reverse trend in the detection rate of *clostridium* may also be due to intermittent contamination of the hand dug wells.

Apart from well 10 (OMD 2), which was located less than 2 m from a stream, turbidity showed consistent reduction with increase in rainfall events and time. Ninety two percent of the wells (from 48% at the beginning of rains) had < 5 NTU by the peak of the rainy season in July. This trend suggests groundwater recharge by rainfall in the study area.

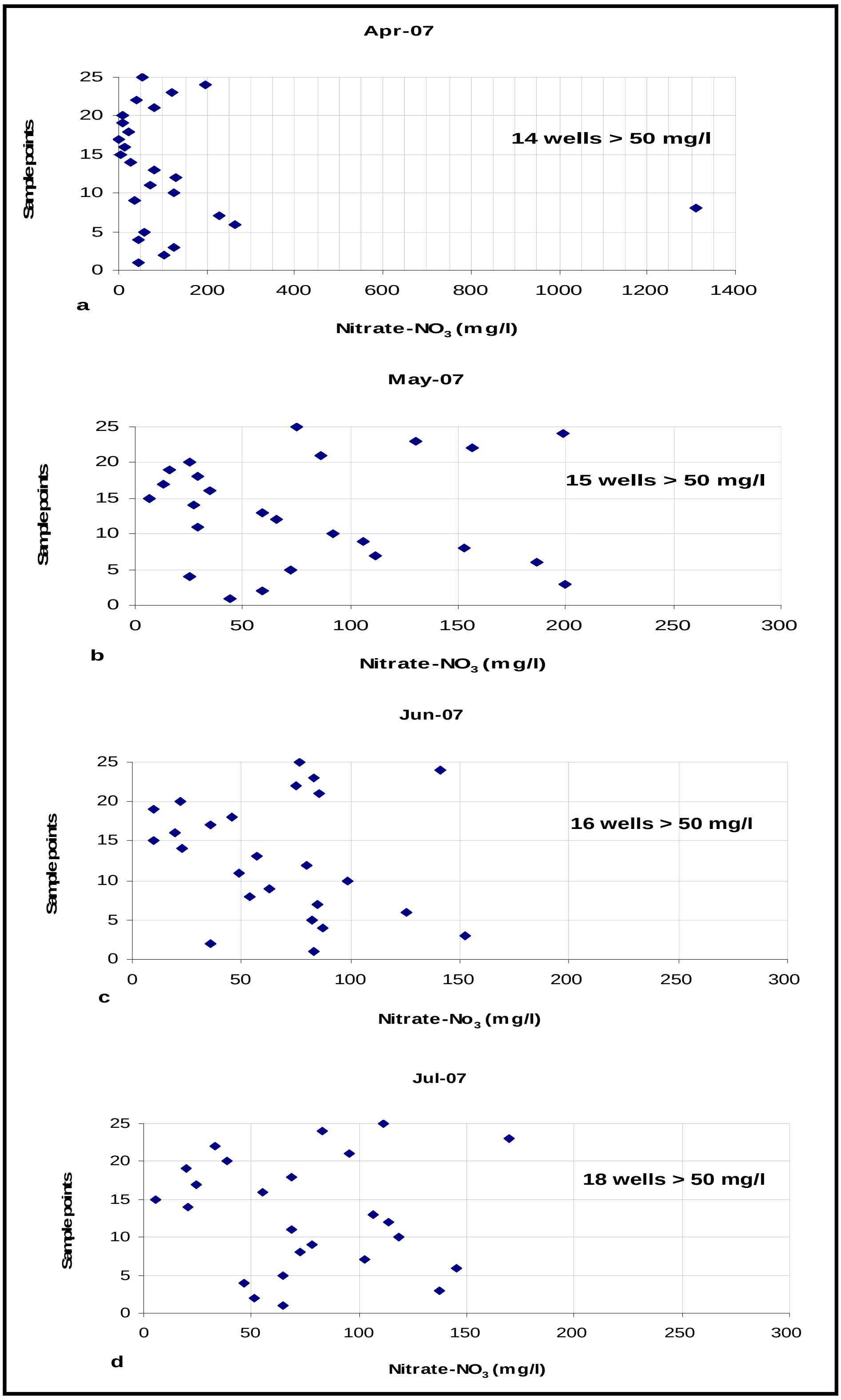
Similarly, the highest value (1,312 mg/l) for nitrate-NO_3 was recorded at the onset of rains (Figure 7-3a) but the number of wells with more than 50 mg/l of nitrate-NO_3 is more by the peak of the rainy season - July (Figure 7-3d). The prescribed limit of nitrate-NO_3 in drinking water is 50 mg/l (WHO, 2004a). This trend again suggests the occurrence of maximum contamination of hand dug wells at the beginning of rains.

The results, which show that the peak water quality deterioration coincides with the beginning of rains is expected. Washing of accumulated surface contaminations and organisms by runoff and via water percolating through the soil matrix respectively are known to be highest at the onset of rains (Barrett et al., 2000b). Well water quality deterioration, which peaks at the transition to wet season with first flush from rainfall is also common. Shallow groundwater sources found in urban areas often show pronounced seasonal variations in especially microbiological quality, with significant deterioration during the onset of the wet season (Howard et al., 2003).



NB: Data collection, April – July 2007; N = 100 samples

Figure 7-2: Variation of total coliform and turbidity of self supply hand dug wells with daily rainfall in Abeokuta, Nigeria



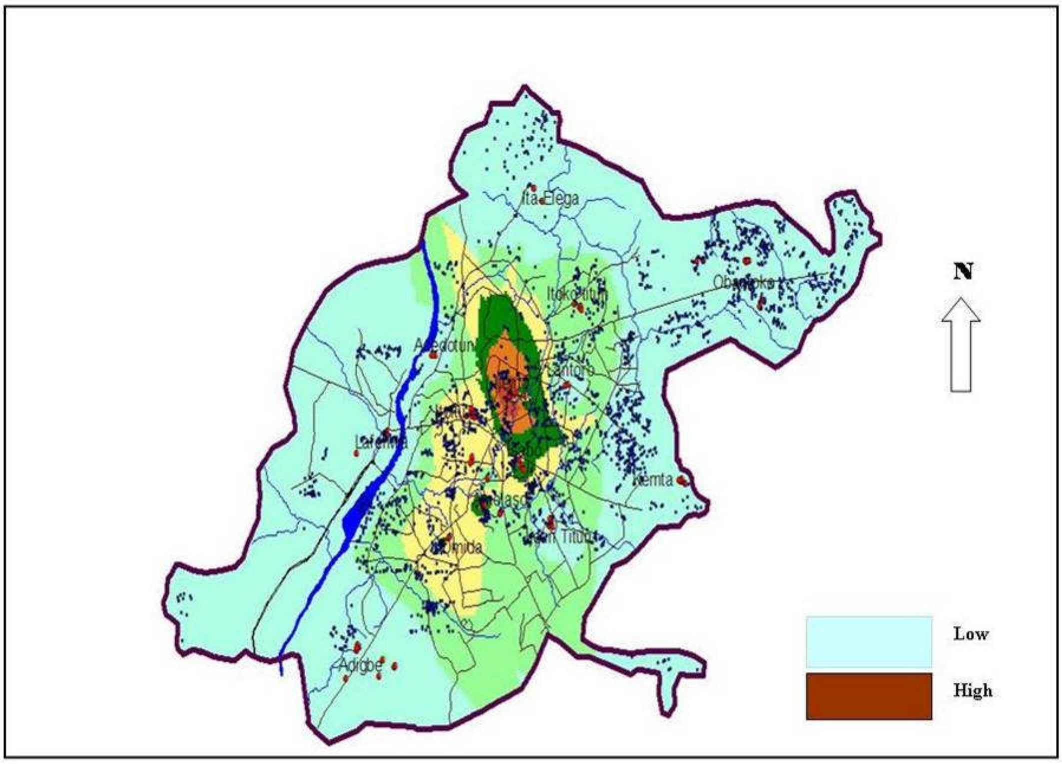
N = 25; NB: For April 07, the X axis is different from the other months, ranging from 0 – 1,400 mg/l

Figure 7-3: Nitrate-NO3 values across wells with time (April to July 2007)

7.1.4 Impact of land use on hand dug wells water quality

Land use exerts an influence on ground water quality by causing fluctuations in the concentrations and distribution of water quality parameters. The effect generated by land use is noticeable in especially the EC values of the sampled wells. The highest values of EC (µs/cm) were recorded consistently in well 17 (ITK 3) of Group 4 (Cottage industrial area). The EC values are far beyond the permissible 1000 µs/cm (1,753; 1,656; 1,589; 1,448 µs/cm from April to July respectively). EC indicates the total salt content, or Total Dissolved Solids, for any given water at a specific site. The high EC concentrations in the well at ITK 3 thus signifies the degree of ion contents in the sampled well due to chemical discharges from the tie and dye cottage industry. A reduction in EC values with increased rainfall events may suggest groundwater recharge and dilution influence of the ions.

Generally, the concentrations recorded for pH, EC, nitrate-NO_3, turbidity, and the microbial parameters in hand dug wells of Group 5 (Control) were lower relative to the values recorded for Group 1 wells. Group 5 wells were located in the low population density areas. Group 1 wells were in the high population density zones. Low water quality values indicate the influence of population density on well water quality. Figure 7-4 shows that the most polluted area of Abeokuta was essentially the core centre of very high population density with no physical town planning.

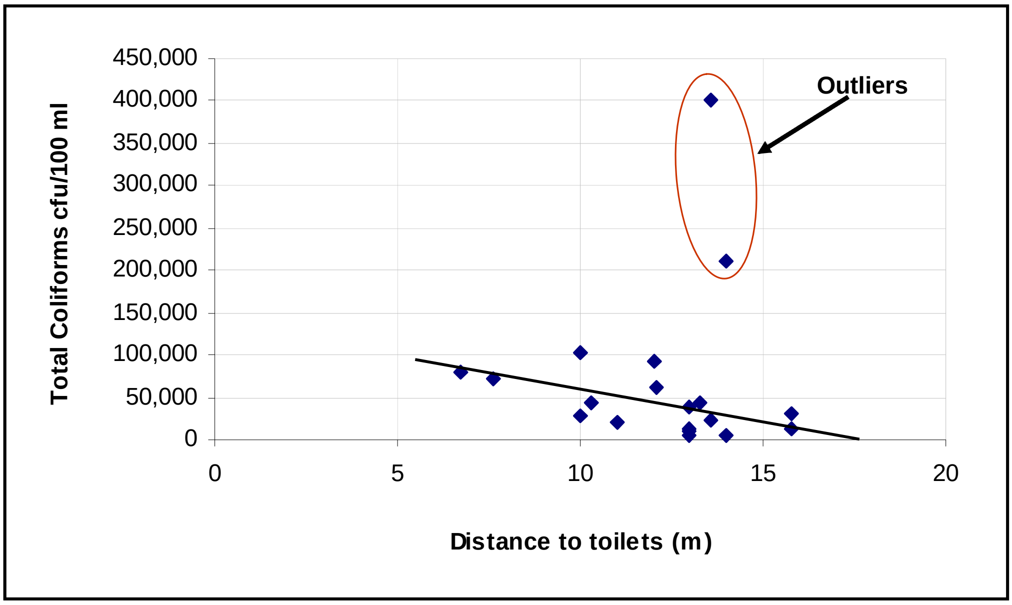


N = 82 wells; Generated using Arc view 3.3

Figure 7-4: Map of Abeokuta showing the spread of Nitrate-NO_3 concentrations in mg/l

7.1.5 Levels of contamination in relation with water safety threats

Proximity to toilets is one of the major water safety threats derived in the research. An investigation of the total coliform count for wells with toilets less than 15 m away was carried out. The relationship is shown in (Figure 7-5). If the two outliers are removed (TC values of 400,625 and 209,750 cfu/100 ml of water) then a weak but inverse relationship is apparent. The rationale for removing the two outliers relates to the particular environment of the two wells (KMT 4 and OMD 2). The sanitary survey score for the well at OMD 2 is 17 indicating a poor environment. The well at OMD 2 is uncovered, had low-level wellhead, and located 3.3 m from a stream. The sanitary condition of KMT 4 is moderate (29) but the well at sampling time was being used for building construction. Construction workers use different un-kept buckets to draw water on demand. From observation it was found that these wells were probably been polluted with coliforms from animal faeces due to the lack of cover (OMD 2) and low well head (OMD 2) and use of un-kept multiple buckets (KMT 4) rather than the proximity to the toilets. The trend is expected. Schmoll et al. (2006) suggests that concentrations of contaminants decrease with distance along groundwater flow path.



N = 17; R^2 = 0.4; y = -7589x + 131,452

Figure 7-5: A chart depicting the total coliform counts (cfu/100 ml) in relation with distance (m) of hand dug wells to toilets in Abeokuta, Nigeria

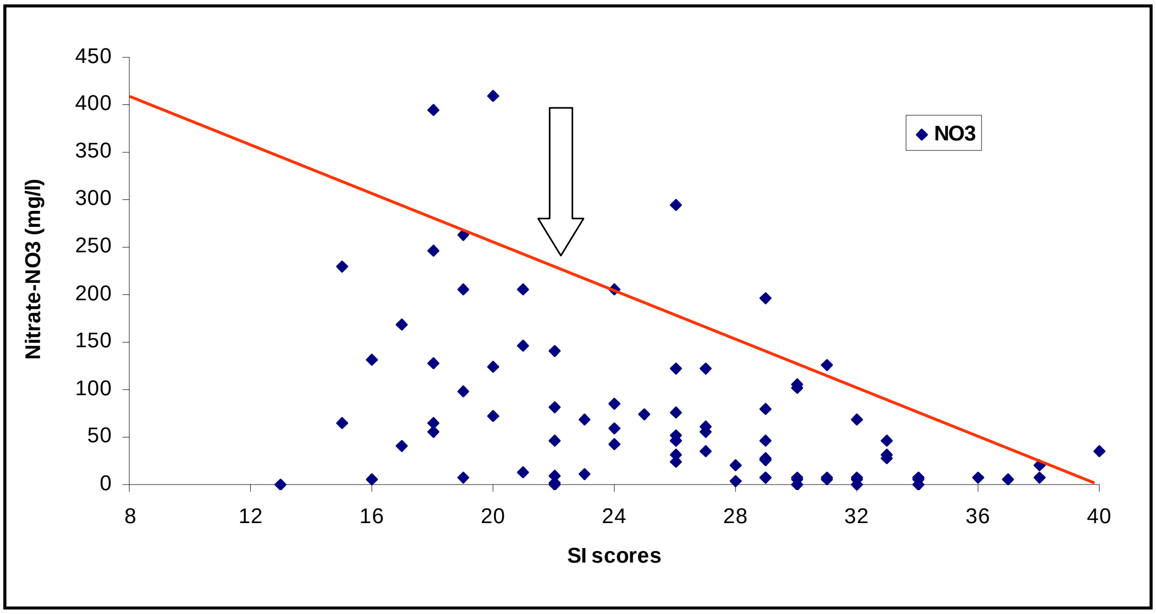
7.2 Sanitary Inspection Results

SI 2 sanitary inspection scores are used to derive the results in this section.

7.2.1 Relationship between sanitary inspection scores and contamination indices

Generally, it is expected that sanitary inspection scores could give a good guess of the contamination condition of hand dug wells. Lloyd and Bartram (1991) made a similar inference that sanitary risk score is a useful indicator of microbial contamination. To verify the general claim, the SI scores are plotted against the nitrate-NO_3

concentrations. High scores indicate good sanitary conditions. As shown in Figure 7-6, no conclusive relationship exists between the SI scores and the nitrate–NO_3 concentrations of the hand dug wells.



N = 81; NB: The actual possible relationship may be found below the red diagonal line and the arrow; SI scores range from 8 (worst possible) to 40 (best possible); Source: Field data

Figure 7-6: Variation of sanitary inspection scores of well area with nitrate-NO_3 contents of hand dug wells

However, rather than focusing on the apparent lack of relationship between the SI scores and the nitrates-NO_3 values, it may be worth noting a possible relationship highlighted below the diagonal line in Figure 7-6. The diagonal line of the triangle may be presenting the maximum expected nitrate-NO_3 value for a particular sanitary score. This possible relationship also suggests that the likely level of contamination may be predicted from SI scores in the absence of actual water quality testing.

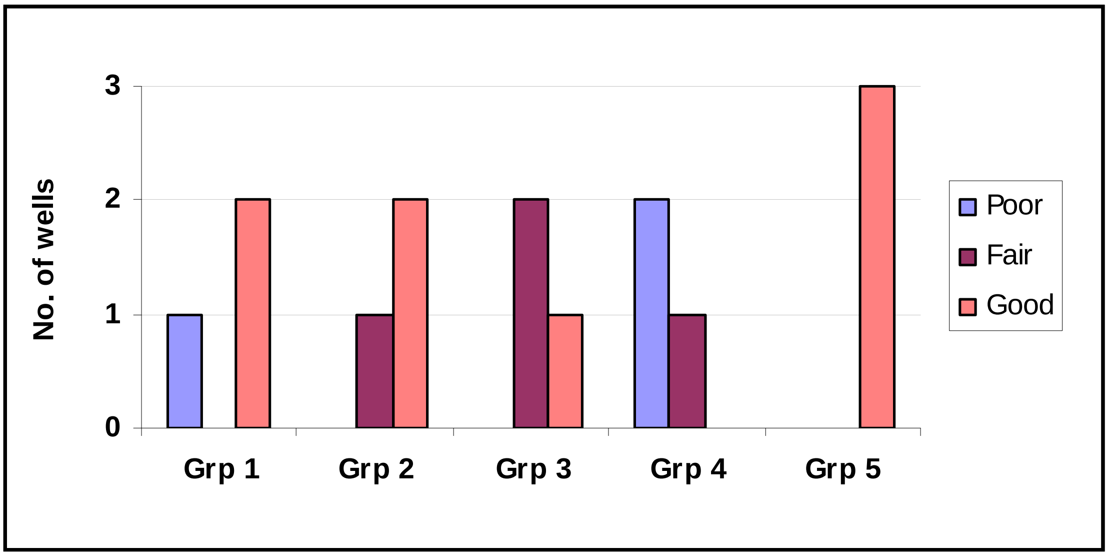
A similar possible relationship was inferred by Nussbaumer in 2008 (Nussbaumer, 2008). Nussbaumer detected very little relation between faecal contaminations (Thermotolerant coliforms) and sanitary scores but derived maximum expectable thermotolerant coliform concentrations for a certain sanitary score. The recurrence of a likely relation between sanitary scores and microbial contaminations indicated by nitrate-NO_3 levels or coliform counts is worth being given further attention in research. The relationship may prove a useful key in drinking water quality modelling.

7.2.2 Sanitary inspection scores across land use

Another category of outcome to highlight is the spread of SI scores across the various land use (Groups 1 to 5) within the study area. Scores from SI 2 form was used for this part of the results analysis. SI 2 had eight questions, which could be weighted 1 – 5. One being the worst score (poor sanitary condition). Therefore the scores across all the wells could range from 8 (worst possible) to 40 (best possible).

Poor, fair and good in Figure 7-7 can largely be interpreted as un-protected (UP), semi-protected (SP) and protected (P) wells respectively. When the SI score is within 30 - 40, the well is considered protected or good. When the SI is 8 - 18, the well is poor and 19 - 29 is fair. Figure 7-7 shows that good wells are found more frequently in group five and group four has no good wells. Group 1 represents residential and high population density areas. Group 2 wells are located in and around commercial (market) centres. Group 3 wells are found around public or private institutions like hospitals. Group 4 represents wells within and around the cottage industrial zones while group 5 wells are within the low density residential areas. Group 5 is also the control group.

The implication of the observed outcome is that the level of hygiene in well handling and quality of construction in group five is better than in other groups. The outcome may be connected with the socio-economic status and possibly the level of modernization (implying that the quality of modern well construction is better) in group 5. As mentioned above, group 5 represents low population density region but also typifies areas with modern development and city expansion.



N = 15; The range of SI scores for Poor wells is 8 – 18; Fair is 19 – 29, and 30 – 40 for Good wells

Figure 7-7: The variation of sanitary inspection scores over land use patterns in Abeokuta, Nigeria

7.3 Analysis of Risk

In the course of the research, a total of 99 hand dug wells were sampled for water quality analysis and sanitary inspections. Repeated water quality measurements was however limited to 41 (25 wells in 2007 and 16 wells in 2008) of the wells. Repeat visits for water quality sampling to the 41 wells allowed access for repeat observations of the sanitary conditions of the wells. Consequently, qualitative risk assessment based on hazardous events approach was limited to the 41 wells.

An example of qualitative risk assessment of one of the hand dug wells is shown in Table 7-3. The qualitative risk assessments for each of the 41 wells are presented in Annex 6. The progression of the risk analysis is shown in Figure 7-8.

Table 7-3: Qualitative risk analysis of a self supply hand dug well (AMLS 1) in Abeokuta, Nigeria

Hazardous events	Causes	Hazards	Pathway	Likelihood	Impact	Risk score
Ingress of contaminants (rusted particles, dust, debris, waste water) directly into well	Holes in metallic Well cover	Microbes and chemicals (Fe)	Wellhead / surface entry	5	2	10
Direct introduction of contaminants into well	Use of un-kept bucket and rope left indiscriminately around well. Use of multiple buckets from hygienically un-ascertained sources/places. Hand/surface pump not installed.	Microbes Solids	Surface entry	5	4	20
Percolation of waste water into well	Lined public drain <0.3 m from well conveying untreated waste water	Microbes, chemicals	Sub-surface entry (unlined well)	2	4	8
Splashing of waste water into well	Users throwing of waste water into drain 0.3 m from well, and conveying untreated waste water	Untreated waste (microbes, chemicals)	Surface entry	4	2	8
Ponding of wellhead area	Absence of apron	Microbes	Sub-surface entry	5	2	10
						56

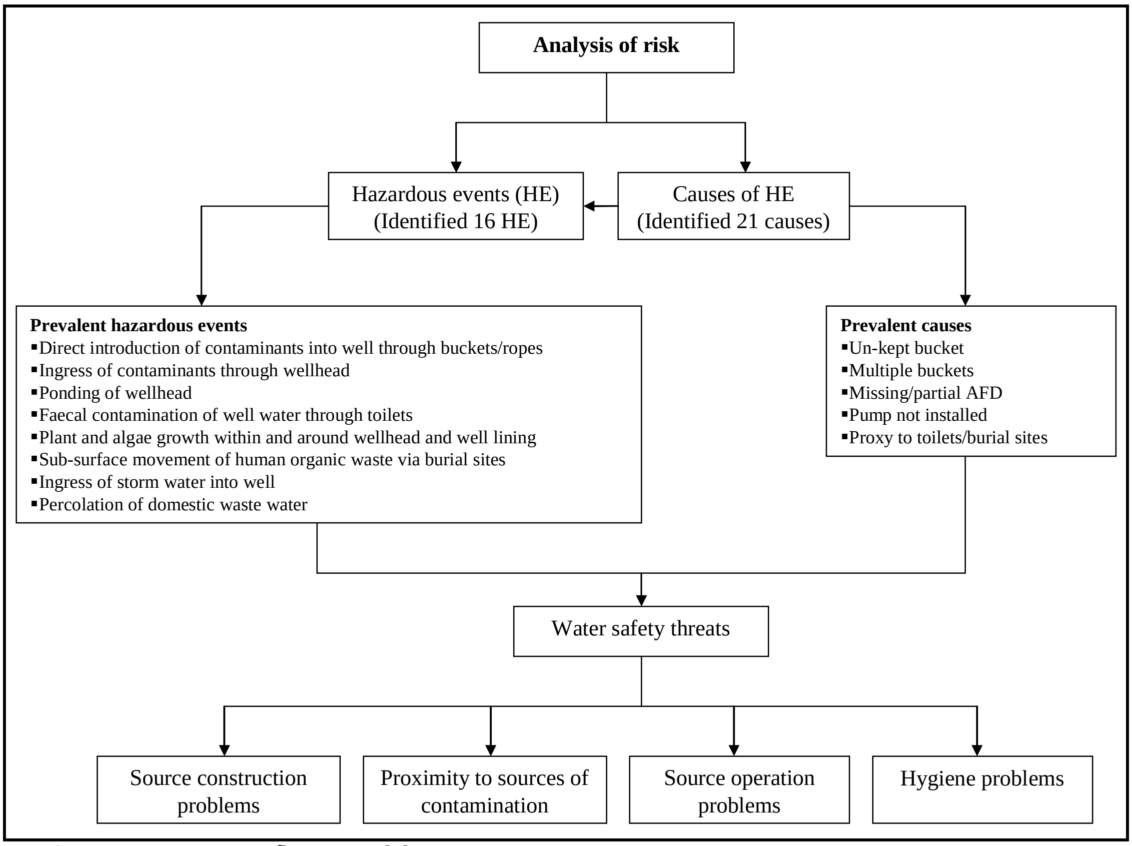
Key:

Likelihood of occurrence:

5 Almost certain: more than once per day
4 Likely: once per day
3 Moderate: once per week
2 Unlikely: once per month
1 Rare: once per year

Consequences/Impact:

5 Catastrophic: Mortality expected from consuming water (i.e. causing death)
4 Major: Morbidity expected from consuming water (causing disease)
3 Moderate: Major aesthetic impacts possibly resulting in use of alternative, but unsafe water
2 Minor: Minor aesthetic impact causing dissatisfaction, but not likely to lead to use of alternative less safe source
1 Insignificant: No detectable impact



NB: AFD represents apron, flooring and drainage

Figure 7-8: Analysis of risk: progression

7.3.1 Hazardous events

A total of sixteen different hazardous events (HE) are identified and presented in order of frequency of occurrence in Table 7-4. Eight of the sixteen hazardous events occurred most frequently in the selected hand dug wells. Descriptions of the eight most frequent hazardous events in order of frequency of occurrence are as follows:

1. Direct introduction of contaminants into wells, which occurs with 40 of the 41 wells, has to do with the usage of un-kept and/or multiple buckets and ropes from hygienically unascertained places.
2. Ingress of contaminants into well is a function of the state of the well cover – presence or absence of cover, seal proof or prone to leaks/holes, rusted or

damaged in any form. Ingress of contaminants also relates to the daily non-seasonal contaminants entry as against the seasonal ingress of storm water.

3. Ponding of well head area has to do with missing apron, drainage and cement flooring.
4. Faecal contamination relates to proximity of wells to toilets.
5. Plant and algae growth within and outside wellhead and lining
6. Human organic waste relates to proximity of burial sites or graves to wells
7. Ingress of storm water through gaps between the wellhead and ground surface
8. Percolation of domestic waste water from unlined drainages within well area.

Descriptions of the other eight hazardous events remain as presented in Table 7-4.

Table 7-4: Qualitative risk assessment of hand dug wells in Abeokuta, Nigeria: Hazardous events in order of frequency of occurrence with corresponding water safety threat classification.

	Hazardous events	Frequency	Water Safety threat classification
1	Direct introduction of contaminants into well through buckets/ropes	40	1
2	Ingress of contaminants through wellhead	35	2
3	Ponding of wellhead	24	2
4	Faecal contamination of well water through toilets	23	3
5	Plant and algae growth within and around wellhead and well lining	21	2
6	Sub-surface movement of human organic waste via burial sites	18	3
7	Ingress of storm water into well*	11	2
8	Percolation of domestic waste water	8	2/3
9	Elevated turbidity (> 5 NTU) due to poor well structure and maintenance	6	2
10	Well water contamination through animal faeces	5	3
11	Pool in cracks on cemented floor	3	2
12	Splashing of waste water into well	2	1
13	Percolation of un-treated dye waste water into well	2	2/3
14	In-flow of stream water	1	3
15	Loss of buckets in well	1	1
16	Introduction of cement and masonry materials in well*	1	1

N = 41; 1 = Source operation problems; 2 = Source construction problems; 3 = Source proximity to sources of contamination (burial sites, toilets and un-lined drainages); * Event-based hazardous occurrence; NB: Frequency denotes the number of wells out of 41 wells in which the observed hazardous event occurs

In order of priority (based on frequency of occurrence) therefore, water safety of self supply wells on the basis of Table 7-4 is compromised through:

- Usage of un-kept and/or multiple buckets and ropes (or bucket related threats)
- Faulty well cover
- Absence of apron, flooring and drainage, and
- Proximity to burial sites, toilets and unlined drainages

The second and third of the four bullet points could be merged and replaced with poor well construction or low quality well features, thereby reducing the water safety threats to three. These three water safety threats are referred to and classed as:

1. Source operation problems
2. Source construction problems, and
3. Proximity to sources of contamination specifically burial sites, toilets, and unlined drainages.

Water users identified similar sets of water safety threats. Threats relating to well operation, well construction, and water quality (6.2.4).

By sorting the sixteen hazardous events into the three major threats classification, eight (or 50%) of the hazardous events relate to construction problems, six (or 38%) relate to proximity to sources of contamination problem while only four (or 25%) are a function of source operation (Table 7-4). In Table 7-4, percolation of untreated domestic and dye waste water is seen as a function of both well construction and proximity to source of contamination. The overlap made the total of the above percentage 3% higher than 100. Absence of drainage classifies percolation of especially domestic waste water as a source construction problem. Tie and dye processing activities carried out close to a drinking water source classify the hazardous event as a problem of proximity to source of contamination.

The implication of the above analysis is that, while the three identified threats are the most critical to hand dug wells, targeting water safety intervention towards improving well constructions will lead to 50% reduction in hazard causing events. This result is consistent with Howard et al. (2003). The authors noted the importance of improving sanitary completion of shallow groundwater in Kampala, Uganda. In a similar development, Foster (2008) suggested that appropriate protocols for well construction, operation and for effective wellhead protection should be a key management concern for self supply wells.

Another important observation from Table 7-4 is that the less frequent hazardous events can be resolved with intervention in the three main classes of water safety threats. For instance, hazardous events number 9, 11, and 14 can be resolved with improved well construction. Hazardous events number 12, 15, and 16 will be eliminated once a safe well operation procedure is in place. And finally hazardous events number 10 and 13 will be tackled once problems relating to proximity to sources of contamination are solved.

It should be noted that at least two (HE 7 and HE 16) of the identified sixteen hazardous events can be referred to as event-based hazardous occurrence (Table 7-4). Ingress of storm water (HE 7) is an event caused by rainfall. Introduction of cement and masonry materials into hand dug well (HE 16) occurred as a result of ongoing building construction at the well site.

7.3.2 Causes of hazardous events

Twenty one different causes are responsible for the hazardous events, which are identified in the previous section (Table 7-5). In terms of the frequency of occurrence, five of the 21 factors represent the most prevalent causes. The first prevalent cause is due to non-installation of pump. Usage of a dedicated pump is identified as the best practice for source operation. The second cause is associated with the common source operation practice; usage of bucket and rope. Absence or partial provision of well apron, flooring and drainage is third. While proximity to toilets and missing well covers are the fourth and fifth prevalent causes respectively.

Table 7-5: Causes of hazardous events in hand dug wells of Abeokuta, Nigeria

	Lists of causes	Frequency	Water safety threat classifications
1	Pump not installed	15	1
2	Un-kept bucket	12	1
3	Multiple buckets	12	1
4	Missing/partial AFD	11	2
5	Proxy to toilets	10	3
6	Missing well cover	7	2
7	Exposure to moisture and sun	7	2
8	Damaged well cover	5	2
9	Users' hygiene behaviours[a]	5	4
10	Proxy to burial sites	5	3
11	Metallic well cover frame	4	2
12	Proxy to drains	4	3
13	Un-kept well area	4	4
14	Goods on well cover	2	4
15	Un-washed well water tank	2	4
16	low-level well head	1	2
17	Faulty flooring	1	2
18	Moist and dark inside well head	1	2
19	Animals in/around water	1	3
20	Low water level	1	2
21	Grass land beside well head	1	2

[a] Users' hygiene behaviour relates with cooking and dish washing, laundry, bathing and toileting activities around well; AFD: Apron, flooring and drainage; 1 = Source operation problems; 2 = Source construction problems; 3 = Source proximity to sources of contaminations (burial sites, toilets and un-lined drainages); 4: Hygiene problem; NB: Causes are presented in order of frequency of occurrence and not in order of threat classifications.

Table 7-5 also shows classification of the 21 hazardous event causes into water safety threat classes. Aside the three water safety threat classes presented in Table 7-4, an additional water safety threat - users' hygiene behaviour around the well area - emerges with the classification of the 21 causes. Water users' hygiene practices around the well include cooking and dish washing activities, and laundry, bathing (especially children) and toileting activities. Toileting activities particularly refer to potty and anal washing near the well.

From Table 7-5, three (or 14%) of the causes are classified as source operation related. Ten (or 48%) of the 21 HE causes are associated with source construction. Four (or 19%) are due to proximity to source of contamination and the last four (or 19%) causes are due to users' hygiene behaviour.

Associating 48% of water safety problems with source construction again confirms that targeting water safety intervention towards improving source construction is critical to health and water safety in the study area. Improvement in source construction could reduce water safety problems by almost half. Focusing on hygiene education would also improve water safety practices by about 20%.

7.4 Risk Characterisation

A semi-quantitative matrix, which applies guidelines from literature (WHO, 2004a; Godfrey and Howard, 2005), sanitary observations of wells, and researchers' knowledge of the study area, is used in risk characterisation. Risk ranking is presented in this section in two parts. The first involved characterisation of the eight most occurring hazardous events. The second risk ranking involved hazardous events characterisation for generic application. The final objective of the research is to recommend appropriate water safety plans for self supply systems.

7.4.1 Characterisation of individual hazardous events

The average risk scores of the eight most frequent hazardous events for the selected 41 wells are presented in Table 7-6. Table 7-6 identifies five major risks associated with self supply wells in Abeokuta. The most important risks comprise two hazardous events. Hazards introduced through the usage of un-kept and multiple buckets. And water contamination from storm or flood water through large openings between wellhead and the ground surface. The two risks have equal rating (average risk score of 19). Introduction of contaminants occasioned by the presence of burial sites often located less than 10 m to wells represent the second rated risk to hand dug wells in the study area. Family burial sites located within owned landed property is common practice in the study area. The third rated risk is as a result of open or uncovered wells. The fourth rated risks involve two hazardous events; the growth of plants and algae within and around wellhead and well lining, and ponding of wellhead area. The fifth rated risks also include two hazardous events; percolation of domestic waste water via unlined drains, and faecal contamination of wells through toilets.

Table 7-6: Average risk scores of the most occurring hazardous events across 41 self supply wells in Abeokuta, Nigeria

	Hazardous events	Average risk scores
1	Direct introduction of contaminants into well through buckets/ropes	19
2	Ingress of contaminants through wellhead	15
3	Ponding of wellhead	11
4	Faecal contamination of well water through toilets	9
5	Plant and algae growth within and around wellhead and well lining	11
6	Sub-surface movement of human organic waste via burial sites	16
7	Ingress of storm water into well	19
8	Percolation of domestic waste water	9

The usefulness of the above risk ranking is to identify the important or critical risks to self supply wells in the study area. Critical risks receive focus attention in risk management. And equal rated risks require equal degree of attention. The five most critical risks thus should receive or be the focus of risk management activities and water safety intervention for hand dug wells in the study area.

It is however interesting to note that the risk associated with bucket related threats have higher scores than the risks associated with proximity to toilets. Risk of faecal contamination of wells associated with proximity of wells to toilets has previously been found to be of more concern to shallow dug wells (Howard et al., 2003). In this study, toilets are absent in some of the houses where the observation wells are located (7.4.4).

The approximate location of the average risk scores of the most occurring hazardous events is shown on the risk ranking matrix in Table 7-7. Table 7-7 shows that the average risk scores occupy or are located on four different colour shades; identifying four risk categories, namely:

- Very high risks: - involving hazardous event (HE) 1 and HE 7
- High risks: - HE 2 and HE 6
- Medium risks: HE 3, HE 4 and HE 5
- Low risks: HE 8

Table 7-7: Risk ranking matrix: approximate location of average risk scores of eight hazardous events from 41 wells in Abeokuta, Nigeria.

Likelihood	Impact				
	Insignificant	Minor	Moderate	Major	Catastrophic
Almost certain			15 (2)	19 (1)	
Likely			11 (3)	16 (6)	19 (7)
Moderate			9 (8)	11 (5)	
Unlikely					9 (4)
Rare					

(1): Direct introduction of contaminants into well through buckets/ropes; (2): Ingress of contaminants through wellhead; (3): Ponding of wellhead; (4): Faecal contamination of well water through toilets; (5): Plant and algae growth within and around wellhead and well lining; (6): Sub-surface movement of human organic waste via burial sites; (7): Ingress of storm water through wellhead gaps into well; (8): Percolation of domestic waste water through un-lined drains; NB: Average risk scores are located on four different colour shades indicating four risk categories.

The above risk categorisation is consistent with the water threats classification that is described earlier in sections 6.2.4 and 7.3.1 of this thesis. Bucket related problems and hand dug well construction problems represent very high risks, which requires high priority actions.

The presence of burial sites within an unsafe distance to wells is a priority risk that calls for immediate action. The practice of locating burial sites or graves within residential properties conflicts with groundwater safety. Discontinuation of the practice would however require the provision of affordable and accessible family or community burial grounds. Accessibility will be in terms of minimum bureaucratic procedure to procure such private or public asset.

Uncovered or open wells, missing or damaged well covers is another priority risk that requires quick attention. One of the interviewed water users also identified uncovered wells as an important water safety problem in the study area (R31; 6.2.4). The high risk associated with uncovered wells suggests, among others, that the introduction of well construction guidelines or standards as a way of discouraging open wells or unrepaired well covers may be an appropriate action.

The hazardous events categorised as very high and high risks suggests that interventions targeted to improve well construction and operations, coupled with actions to discourage proximity of sources of contamination to wells remain the most critical to hand dug wells water safety in the study area.

Faecal contamination of hand dug wells via toilets is one of the hazardous events in the medium risks category (Table 7-7). It is important to state that the resultant risk position of proximity of toilets to wells derived in this research should not undermine the potency of the hazardous event. The risk scores used for the risk categorisation are average scores. Toilets are absent in some of the well locations and distance of wells to toilets in some of the locations is more than 10 m (Annex 6). Ten metre distance is generally regarded as a safe distance of assets like toilets to dug wells. Where toilets are absent, onsite defecation or faeces disposal on solid waste dump is common.

7.4.2 Generic characterisation of hazardous events

The risk scores for each of the identified hazardous events in the 41 wells are summed up to derive total qualitative risk score (QRS) for each wells. For example the total qualitative risk score for the well presented in Table 7-3 is 56. The range of the QRS across the 41 wells is from a minimum of 10 to maximum 130 number units. The QRS is divided up subjectively into five risk groups, namely:

- No risk: - QRS less than or equal to 10 (QRS < 10)

- Low risk: - QRS more than 10 but less than 50 (QRS > 10 - < 50)
- Medium risk: - QRS 50 to 55
- High risk: - QRS more than 55 but less than 100 (QRS > 55 - < 100)
- Very high risk: - QRS more than 100 (QRS > 100)

Based on the above subjective risk classifications the number of wells in each categories are 1, 15, 2, 18 and 5 respectively (Table 7-8).

Table 7-8: Risk characterisation based on qualitative risk scores (QRS); N = 41

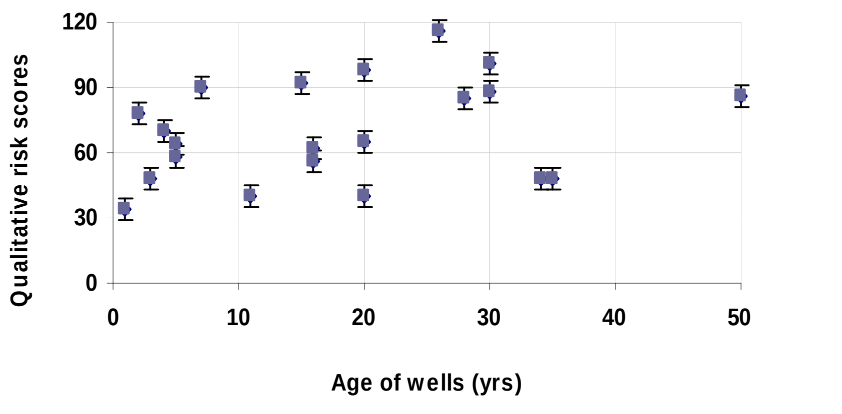
	Number of wells				
	No risk (< / = 10)	**Low risk (> 10 - < 50)**	**Medium risk (50 – 55)**	**High risk (> 55 - < 100)**	**Very high risk (> 100)**
QRS	1	15	2	18	5

Table 7-8 shows that in terms of the number of wells within the risk categories, hand dug wells in the HR category requires priority attention in generic risk management interventions followed by the LR and VHR wells respectively. It is however important to note that apart from the number of wells within the classified risks, implementation of priority action would require the consideration of cost. The cost implication of water safety plans is not within the scope of this research. Further research is therefore advised to address the cost (monetary or otherwise) of self supply systems water safety development and implementation.

7.4.3 Qualitative risk scores with age of hand dug wells

The possible influence of the level of modernization on the SI scores is hinted in 7.2.2. By categorising hand dug wells into modern or old, age of wells could be used as a measurable indicator for level of modernization. The quality of construction, which can be indexed by the type of well (P, SP or UP) could also serve to indicate socio-economic status in the context of safe self supply systems.

To ascertain the possible influence of the level of modernization or socio-economic status on the variations observed in the SI scores across land use, the risk scores were plotted against the age of wells measured in years (Figure 7-9). No useful statistical relationship is established but variability or fluctuation in the risk scores across the age of wells is noted. The range of QRS of wells below 10 years is within 30 and 90 while the range of scores in older wells is from about 30 to 120 QRS. Visual inspection of the wells typified in Figure 7-10 suggests that the observed wider degree of variation in the QRS of old wells is likely. The quality of construction in old wells is more varied as is the well handling (hygiene), and management. Variability in modern wells is however generally limited to well management issues.



N = 24; R^2 = 0.1; Errors bars are standard errors

Figure 7-9: Variation in qualitative risk scores with age of hand dug wells in Abeokuta

OMD 6

A modern (4 years) well

ABW 2

An old (20 years) well

Source: Field data 2007

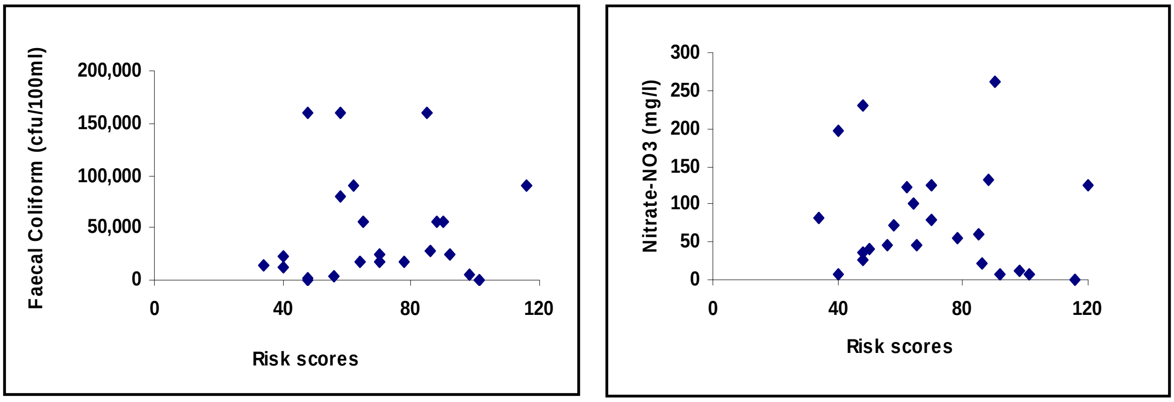
Figure 7-10: Examples of a modern and an old well

7.4.4 Correlation between qualitative risk scores and sanitary inspection scores with contamination indicators; nitrate-NO_3 and TC

The data shows that there is no direct relationship between QRS and faecal coliform counts (Figure 7-11a). This is unexpected and suggests that there are some other factors, which contributed to the risk scores as an indirect source of contamination.

Similarly, the relationship between the QRS and the nitrate-NO_3 levels is inconclusive (Figure 7-11b). It may be difficult to establish a relation between the QRS and nitrate-NO_3 values due to the absence of some risk causing factors in some of the well locations. For example, there are no toilets in any of the selected well locations in Itoku area of Abeokuta. Absence of toilets may thus be responsible for low nitrate-NO_3 concentrations of wells in the area (e.g. NO_3 = 0.4 mg/l in ITK 3). However, the sanitary condition, hygiene level and well handling in Itoku area is poor resulting in high risk scores for wells within the region (Figure 7-12). It is nonetheless important to note at this point that the proximity of neighbouring toilets to wells under risk assessment should be taken to account during sanitary inspections. Taking a neighbour's toilet location into account in the context of self supply systems is important because of individual land and property ownerships and rights. Property owners usually do not require permission from fellow land owners to locate assets like wells or toilet within owned property. There may however be sub-surface interaction between these differently owned assets as a result of proximity. Rojas et al. (1995) noted that the presence of preferential flow routes (like close wells or toilets) into the aquifer, which bypass the un-saturated zone, represents a highly significant risk to the population using ground water as source of water.

The sanitary condition in wells at OBK 9 and IJM 5 can be classified as moderate (40 and 48 respectively), but the nitrate-NO_3 contents recorded for both wells are 197 and 230 mg/l respectively. The observation at these locations suggests that though there are many pathways to well water contamination, sub-surface entry remains a major route. On the other hand, the interaction between risk scores and nitrate-NO_3 contents in the well at SKN 2[35] imply that proximity to toilets, more than any other sources of contamination (safety threats) still play a key role in water safety. It is recalled that the risk associated with proximity to toilet is previously ranked as the 5th hazardous event (7.4.1). However, the well at OMD 2 (120 QRS vs126 mg/l of nitrate-NO_3) portrayed a typical or the expected trend between risk scores and nitrate-NO_3 levels of water.



a: N = 24; R^2 = 0.003; Source: Field data April 2007

b: N = 24; R^2 = 0.02; Source: Field data April 2007

Figure 7-11: The interaction between derived qualitative risk scores, faecal counts and nitrate-NO_3 contents of hand dug wells

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[35] Some of the characteristics of the well point at SKN 2 are: Risk score, 101; NO_3 level, 6.6 mg/l; distance to toilet, 15.8 m; distance to burial site, 3 m; No well lining; Mode of operation is through multiple buckets.

Figure 7-12: Sanitary conditions of six hand dug well sites

7.5 Chapter Summary

In conclusion, a number of outcomes are derived from the presented results. However a list of the major findings corresponding as much as possible to the outcome from each of the sub-sections are summarised as follows:

- Microbial contaminations of all the sampled hand dug wells in the study area are in excess of 100 cfu100ml^{-1} (7.1; 7.1.2)
- Maximum levels of hand dug well contamination occur at the onset of rains and contamination spreads with increases in rainfall events (7.1.3).

- The line of maximum expected microbial contamination for a given sanitary score derived by relating microbial contents with sanitary scores may prove a useful tool in drinking water quality modelling (7.2.1).
- The sanitary conditions of hand dug wells in residential low density areas are better than in other land use groups. The degree of modernization and/or socio-economic status has a possible influence on hand dug well handling, level of hygiene and quality of well construction (7.2.2).
- The four major water safety threats to self supply hand dug wells in the study area are source operation and construction problems. Others are proximity to sources of contaminations (toilets, burial sites and drains), and users' hygiene practices. The four major threats remain the most critical to water safety interventions (7.3; 7.3.1)
- Improvement in source construction may reduce water safety problems by almost half. Focusing on hygiene education would also improve water safety practices by about 20% (7.3.1)
- Where water quality testing is not feasible, judgements on risk determination could be based on qualitative risk assessments (7.4.2)
- The degree of variation in the sanitary condition of old wells is wider than in modern wells. Varied factors include quality of construction, well handling (hygiene), and well management (7.4.3).
- Proximity to toilets may still play a key role in hand dug well water safety more than any other sources of contamination. Sub-surface contamination entry remains a major route (7.1.5; 7.4.4).

The implication of the listed major outcomes and the most important finding from this chapter is that hand dug well water quality in the study area is poor and hence not safe for drinking. There is also no alternative water source that is particularly safe for drinking in the area. There is therefore an urgent need for water safety intervention.

The identified hazardous events in this research have risk tendencies and thus require one level of risk management attention or the other even if they are low risk events. Priority water safety intervention should however target:

- Construction problems and bucket related issues in the self supply hand dug wells. The highlighted problems represent the most important risks in the study area.
- Risk management actions on LR, HR and VHR wells due to the relatively high number of wells and consequently number of users involved. The wells in the Low risk category require priority action because the number of people served is more than in medium risk category. Hand dug wells in HR category however requires the first attention in generic risk management interventions.

Lastly, this chapter presents the second research objective, which addresses hazards identification. Hazards identification concludes the system assessments aspects of the research. The implication of the self supply wells assessments to water safety plans are discussed in the next chapter.

8 FROM SYSTEM ASSESSMENTS TO WATER SAFETY PLANS

Chapters 6 and 7 capture the system assessments aspect of the research. The evidence provided in the previous chapters show the need for water safety plans for water sources. The results also explained some of the effort needed in water safety interventions, and described some of the activities required to supplement water safety plans. This chapter summarises the need for self supply water safety plans, and focus on how the lessons learnt from systems assessment could be appropriated to self supply water safety plans. The chapter provides activity guidance for water safety development, risk management, and necessary supplement programs. Chapter 8 ends with a brief chapter summary.

8.1 The Need for Water Safety Plans for Self Supply Sources

Semi-protected and unprotected wells together accounts for 88% of the available self supply wells in Abeokuta (Figure 6-1). Fifty percent of the water safety threats to self supply wells in the area are connected with well construction (Table 7-5) and at least 48% of the major causes of hazardous events in wells are related with un-protection and/or semi-protection of wells (Table 7-6). The risk involved with poor well construction range from very high risk to medium risk (Table 7-7).

Self supply hand dug wells serve an estimated 45% of Abeokuta's population. The 45% represents about 114,000 people. Of the 114,000 people, some 85,500 (or 75%) are exposed to free access wells. The remaining 28,500 people (or 25%) use wells with restricted access. Free access wells are synonymous with multiple buckets operated wells implying that users in free access category are exposed to water contamination threats posed by the usage of multiple buckets. Bucket related threat is one of the two very high risk problems (Table 7-5). The threat also represents the most common to hand dug well water safety (occurred in 40 of 41 examined wells).

Water from the self supply wells is used for both ingestion (drinking and cooking) and non-ingestion household activities. The water quality of the self supply sources is poor and not safe for consumption. Hand dug well water quality is influenced by contaminant movement into wells from underground, and wellhead or surface entry. Underground contaminants entry is further impacted by rainfall and land use. The available alternative water sources in the study area are also unsafe for consumption.

The highlighted evidences support the need for source and household level water treatment, and the need for urgent water safety interventions for self supply wells in the study area.

8.2 Guidance to Water Safety Intervention for Self Supply Sources

This section highlights quick guidance steps to water safety interventions for self supply sources. Two guidance categories are presented; water safety plans activity guides, and appropriate risk management intervention. The guides are presented with relevant evidence for guide justification.

8.2.1 Activity guide for water safety plans development

Quick guidance action steps for facilitators in the development of water safety plans for self supply sources include in order (6.2.4):

I. Preliminary investigations:
   - Examine and understand water user perception to the health impacts of their water. The predominant water user attitude to health impact relates with the need for water safety plans.
   - Examine and identify any key factors affecting the attitude of users to the health impacts.
   - Examine attitude of users to water safety. Investigate users' knowledge levels. The exercise help highlights the knowledge areas where appropriate training should be targeted in supporting programs.

II. Identify key stakeholders to be involved in the initial supporting programs. Examples of key stakeholders may include religious leaders, public health educators, and/or health practitioners.
III. Organise initial supporting programs to address the factors affecting the attitudes of users to water and health.
IV. Initiate the training of key stakeholders on the basic knowledge and skills in water safety plans development.
V. Implement water safety plans.

8.2.2 Risk management guide for water safety interventions

Five risk categories are derived from the risk assessments exercise in chapter 7. From Tables 7-4, 7-5, 7-6, and Figure 7-2, the five risk categories are defined as follows:

- **Very high risk (VHR):** - relates to hand dug wells with bucket related threats, ingress of storm water problem and/or nitrates-NO_3 contents more than 100 mg/l.
- **High risk (HR):** - relates to wells with missing or damaged covers, wells within unsafe (< 10 m) distance to burial sites and toilets, and/or with nitrates-NO_3 contents more than 55 mg/l but less than 100 mg/l
- **Medium risk (MR):** - relates to semi-protected wells with missing lining, apron, or well drainage. MR also includes wells within unsafe (< 10 m) distance to toilets, and/or nitrates-NO_3 contents between 50 and 55 mg/l.
- **Low risk (LR):** - is associated with wells within unsafe (< 10 m) distance to un-lined domestic waste water drains, and/or nitrates-NO_3 concentrations greater than 10 mg/l but less than 50 mg/l.
- **Very low (or No) risk (NR):** - relates to wells with qualitative risk score less than 10, and/or nitrates-NO_3 contents of less than 10 mg/l.

The risk management guidelines are based on the proffered risk characterisations and definitions.

The risk management guidelines for WSP interventions for self supply sources in order are:

I. Target risk management activities at HR wells. The aim is to reduce the number of wells in the HR category to zero, and minimise the nitrates-NO_3 contents to below 10 mg/l. Specific objectives would include, among others:
   - The introduction of well construction standards as a way of discouraging open wells or un-repaired well covers.
   - Discontinuation or abolishment of the practice of locating burial sites or graves within residential properties. Discontinuation of the practice will require the provision of affordable and accessible family or community burial grounds. Accessibility will be in terms of minimum bureaucratic procedure to procure private or public burial sites.

II. Embark on risk management works on VHR wells. The aim will be to ensure 100% compliance with established water safety measures to reduce nitrates-NO_3 concentrations to below 10 mg/l. Relevant specific activities would include:
   - Establish the usage of dedicated bucket and rope, and/or encourage hand or surface pump installation with hand dug wells.
   - Encourage compliance with hand dug well construction standards

III. Co-ordinate risk management effort in LR wells. The third risk management activity should aim to locate waste water drains in residences but at a safe distance of more than 10 m to available hand dug well point. Specific activity is to embark and ensure construction of lined domestic waste water drainages.

IV. Intervention activities for MR Wells. The risk management activity aim is to introduce and encourage safe distance between toilets and hand dug wells. Specific actions includes:
   - Enforce compliance with minimum safe distance for new wells.
   - Encourage source and household water treatment for existing wells

V. No specific risk management action is required for NR wells.

8.3 Water Safety Plans Supplementary Programs

Investigation of the water users' attitude and perceptions to water uses, health impact, and water safety uncover the need to educate water users in the study area. Water user perception findings reveal that enlightenment is critical to achieve sustainable water safety development and management. And training of the self supply well owners, users, and identified key stakeholders is crucial to ensure water safety of the sources. Enlightenment and training are considered as supporting programs in water safety developments or plans. This section highlights the various issues that require training or awareness activities in the study area. Each highlighted issue is presented with the evidence to support the training need.

8.3.1 Enlightenment and training needs

The enlightenment and trainings required to supplement water safety plans in Abeokuta, Nigeria are as follows:

I. Awareness/enlightenment campaign:
  - Encourage household water treatment practices (Table 7-1 and 7-2).
  - Create awareness for water safety guidelines: - to align preset water user criteria for good water or water safety conditions with informed or established water safety guidelines (6.2.4).
  - Promote safety alertness/consciousness: - vigilance of the state of water at source or point of use with the need for personal health protection drives water safety actions (Box 6-16).

II. Training programs:
  - The role of God and man in disease prevention (Box 6-4).
  - Water borne/related diseases, causes and transmission routes (Box 6-6, Box 6-7, and Table 6-13)
  - Best practice in disease treatment (Table 6-14, Figure 6-7, & Box 6-10).
  - Identification of regulated medical prescription sources (Table 6-15 and Box 6-9).
  - Water threats and transmission routes (Box 6-13).
  - Water safety measures for household water sources (Box 6-13).

8.4 Chapter Summary

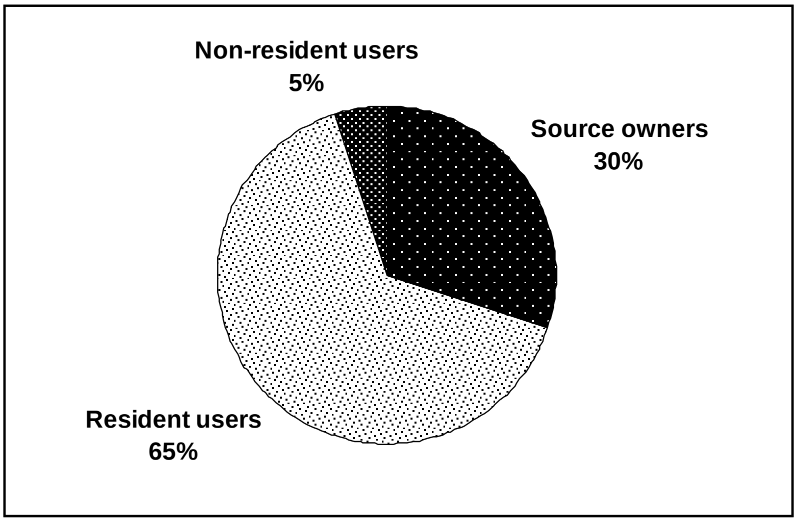
Chapter 8 recaps the major findings of the systems assessments chapters 6 and 7. The chapter also highlights three major implications or relevance of the results from systems assessments to water safety developments and plans. Subsequent chapters will focus on the third and forth research objectives. Chapter 9 will explore particularly the third objective. Focusing on hand dug wells operations, maintenance, and management practices.

9 SOURCE MANAGEMENT – USER PERCEPTIONS

Source or system management relates to the action taken in normal operation or incident conditions. Source management also includes systems upgrade and improvement.

Sixty respondents commented on source management practices. The 60 respondents as shown in Figure 9-1 comprise source owners, SO (30%), resident users, RU (65%), and non-resident users, NRU (5%). Source management practices, users' interpretation of source management and the challenges to hand dug well management are many and diverse. To capture the diversity, findings are grouped into six major themes. The themes are presented and discussed in sub-sections. The number of respondents in each theme is presented within the theme.

This chapter sets out source management definitions, existing management practices, challenges confronting source management, and factors influencing the named challenges. The other themes are source maintenance and improvement measures, and specified roles and responsibilities. The last sub-section summaries the lessons learnt with implications for water safety plans.



N = 60

Figure 9-1: Source ownership profile of interview respondents

9.1 Source Management Interpretations

Source management is interpreted by water users in several ways (Box 9-1). The definitions are:

- Source protection from contamination. Examples include use of dedicated versus multiple buckets or well lining (R5 and R74)
- Maintaining source structure. Involves for instance building a well cover (R8)
- Hygiene check of source operators. Example include prevention of standing with shoes on well-head (R39)
- Cleaning the well area (R41)
- Supervision of source operation. Involves control of the time of operation or locking of well cover (R83)
- Overseeing of access to source, especially access of non-resident users (R83).

R_5:	*'…. but we don't allow people to bring drawer bucket from outside*
R_8:	*'…we build a cover on it and put it under lock*
R_{39}:	*I don't allow people to even come close with their shoes. I put a lot of restrictions on people who fetch the water.*
R_{41}:	*'…to sweep and tidy the well area. It is just something I have made my responsibility*
R_{74}:	*The owners do not allow any other person put their own drawer in the well*
R_{83}:	*If I am not around, I can not see what people are doing. But most of the time I am around and I see the way the people use the well. If need be I scream at people and even ask them not to come back again. So it is either I do not leave the well open or I monitor it.*

Source: Research interviews; I: Interviewer; R: Respondents

Box 9-1: Source management interpretations

9.2 Source Management Practices, Rules and Sanctions

Seven source management practices are evident from Table 9-1. Judging from the frequency of occurrence (from interviews), access control via key collection, locking of dug wells and time management are the popular management practices. The most common practice is however access control through key collection. Access to locked wells is gained only when the owners or resident users open the well. In the key collection approach, non-resident users can have access to wells on demand by asking for the keys.

Two observations are however apparent from Table 9-1. The first observation is that five (1, 2, 3, 6 and 7) of the specified management practices are a form of access control. The second observation revealed that users are being controlled (4 and 5). The people being controlled are in the following text referred to as the controlled group. By implication therefore, the main source management approach from the named management practices is access management.

Table 9-1: Hand dug well management practices in Abeokuta, Nigeria

	Source management practices	Frequency
1	Access to source via key collection *,[a]	8
2	Locking of dug wells [a]	5
3	Time management [a]	4
4	Prevent child operators [b]	2
5	Deny access to non-resident users [b]	2
6	Deny access when water level is low [a]	1
7	Access through tap stands	1

[a] Form of access control; [b] The controlled group; *: Access on demand by asking for the key; N[1] = 23

Aside being the most common control method, a statement by one of the respondent *'The woman is very strict. The well is always locked up. If you need water, you have* *to collect the key from Mama'* (R92) suggest that access through key collection may represent an effective means of access management.

Time management as an access control option is noted by four respondents (R83, R84, R89, and R91). Hand dug wells are opened for operation within a given time period. On average, the specified time period is between 5 am and 7 pm (Box 9-2). The time period suggests that access to well water is permitted only during the day time. The various reasons why access to well water is limited to day time are provided in Table 9-2. The most referred reason however is the concern for the source and water safety.

I:	*Who authorizes the use?*
R_{83}:	*The owners.* ***Once we open the well by 5 a.m. people are allowed to fetch water till 7 p.m. in the evening.***
I:	*Why 5 a.m. to 7 p. m.?*
R_{83}:	*Because of the people to prevent wicked people who may want to contaminate the water or drop dangerous things into the well. Since we could not fence it round*

I:	*How do you look after the well?*
R_{84}:	*We lock the well every night.* ***The well is usually opened between 5a.m and 6p.m*** *every day and residential users will take water first and lock up in the evening.*
I:	*Why do you lock it at night?*
R_{84}:	*You know that anything can happen at night so for security reasons, we lock it at night.*
I:	*Things like what?*
R_{84}:	*People are very wicked; there was a case whereby somebody got killed and the body was dropped into the well of a neighbour and got all the neighbours' residents in trouble. So to avoid such, it's better to lock up. Secondly, we lock up to prevent animals and birds from flying in.*

I:	*What time of the day do you draw water from the well?*
R_{89}:	*Morning to evening.* ***We lock the well by 7 pm***
I:	*Why is that?*
R_{89}:	*To prevent people from throwing dirt or contaminate the water at night*

I:	*What time of the day do you draw water from the well?*
R_{91}:	***The well is open between 7a.m to 5p.m.***
I:	*Why don't you allow fetching beyond those times?*
R_{91}:	*The elders say that ''it is dangerous to fetch water from the well at night''. In fact, there is a myth that "if you allow the fetching of water in the evening, the household will split".*

Source: Field data; I: Interviewer; R: Respondents

Box 9-2: Operation time management; an access management strategy

Table 9-2: Reasons for day time access to hand dug wells

Reasons for day time access to wells	No. of respondents
Un-fenced well [a]	1
Prevent night time water pollution [a]	3
Security reasons	1
Prevent household break-in	1
Prevents animals and birds [a]	1

[a] Associated with source and water safety

The day time access hours appears to suit users' water collection preferences. Table 9-3 shows four categories of preferred water collection times; on demand, strictly morning, morning and evening, and morning and on-demand. Judging by the frequency of preference, 50% of the users are in favour of the chance to be able to access hand dug wells on demand. Water collection on demand is favoured to avoid usage of the water for un-approved purposes *'I fetch the well water anytime on demand, because I do not use it often. If I store the well water, the children could mistakenly bath with it, a situation which I do not like'* (R93).

The remaining 50% however prefer to access water at least in the morning (Table 9-3). Assuming that morning may also be inclusive in on demand, Table 9-3 suggests that 100% of the users prefer to collect water at least in the morning time of the day. The argument that water users prefer to collect water at least in the morning is supported by respondent R81. The respondent reasons that '*It is better in the morning, once other users come around; the water becomes unsettled and dirty'*. Other stated reasons include household cleaning before start of daily occupation. Users are at home in the morning and morning also represents bathing time (Box 9-3).

Table 9-3: Water users preferred water collection times

Preferred water collection times	Frequency	% Frequency
On demand	6	50
Strictly morning [a]	2	17
Morning and evening [a]	3	25
Morning and on demand [a]	1	8
	12	100

[a] Clearly include preference for morning time

I:	*Why do you prefer that time of the day?*
R_{81}:	*Its better in the morning, once other user comes around the water becomes unsettled and dirty*

I:	*What time of the day do you normally fetch water?*
R_{84}:	*Usually morning and evening because I have my bath before leaving for work and before retiring for bed.*
R_{88}:	*In the morning because we need to do household chores before we leave for school*
R_{94}:	*Morning and evening. We go to work during the day; these are the times we are at home*

Source: Research interviews; I: Interviewer; R: Respondents

Box 9-3: Reasons for choice of water collection time

Access management via the locking of wellhead cover implies that especially non-resident users can access dug wells only when the supervision of source operation is intended. The implication is illustrated in the remark made by R83 '*If I am not around, I can not see what people are doing. But most of the time I am round and I see the way the people use the well. So it is either I do not leave the well open or I monitor it*'.

Further implication suggests that unless the condition of supervision is met, there can be no access. To corroborate 'No supervision, no access' respondent R8 opined that all we do is '*lock up the well, if we are out those that want to use it will have to wait;*

if they come and meet it locked they will turn back. It is difficult for such people to break the key'.

On the other hand restricting access to wells due to low water level clearly occurs only when low water level is experienced. Thus while access control through the locking of wellhead cover is a condition-based[36] management approach, access limitation due to low water level is an event based[37] access management strategy.

Access to well water via tap stands is the fifth and one of the least mentioned. The access option is not common because it is more expensive than the previous four access control options. The cost involved in access via key collection for instance includes the cost of pad locks with keys, and bucket and rope. As at the time of the second field study in year 2008, the cost of padlocks with keys, and bucket and rope was about one thousand Naira (National Currency) or £4. The cost implication of the fifth access control strategy is more because the option involves the installation of some form of dedicated motorised pumps. Motorised pumps typically cost about N12, 000 (£48). To avoid the problem of the controlled groups around the well, one of the interviewed source owners set up water distribution lines and allocated two tap stands beyond the property fence to non-resident users. The access option represents the best available practice in the study area. The access option is better because water collection activities are limited to the tap stands away from the well area.

Box 9-4 highlights four rules that source owners and/or resident users apply in the management of hand dug wells. The rules are:

- Prohibition to climb on well head with shoes or slippers on (R39)
- Prohibition of chewing stick in mouth during source operation (R47 and R62)
- Prohibition of individual bucket; strict adherence to the usage of owner's dedicated bucket and rope (R74)
- No talking while fetching (R62)

[36] Supervision requirement (condition) must be met

[37] The management style is informed by the event of low water level

Box 9-5 on the other hand spots three sanctions that are being applied to enforce the stated management rules. The sanctions include:

- Banning the usage of un-authorised bucket (R4)
- Banning of non-compliant users (R9, R83 and R94), and/or
- Subjection of non-compliant user to public embarrassment '*Scream at people*' (R83)

The comments from all four respondents in Box 9-4 claiming '*I or they* (source owner) *do not allow*' suggest that the establishment and promulgation of source management rules are the prerogative of the source owners. And '*I scream at people*' declared by R83 in Box 9-5 equally suggests the role of source owners in the enforcement of source management sanctions.

R_{39}:	*I (source owner) don't allow people to even come close with their shoes. I put a lot of restrictions on people who fetch the water.*
R_{47}:	*I (source owner) told them that they can not come with chewing stick around here or do any dirty things around the well and we don't allow them to use dirty drawer.*
R_{62}:	*I (source owner) don't allow people to talk or use chewing stick beside the well or talk beside it. It's me that knows how much I am spending and have spent on the well.*
R_{74}:	*No, they (source owners) do not allow individuals to use other buckets*

Source: Research interviews; I: Interviewer; R: Respondents

Box 9-4: Existing source management rules

R_4:	*'… whosoever will not be allowed to use other buckets ….*
R_9:	*'… anyone who is not comfortable with it (source management) can go else where.*
R_{83}:	*If need be I (source owner) scream at people and even ask them not to come back again.*
R_{94}:	*'…the person will not be allowed to fetch water another day*

Source: Research interviews; I: Interviewer; R: Respondents

Box 9-5: Sanctions for the enforcement of source management rules

9.3 Major Challenges to Source Management

Six notable challenges confront hand dug well management in the study area (Table 9-4). Three of the six challenges account for more than 80% of frequency of mentioning (Table 9-4). All the six challenges are nonetheless important to hand dug well management. The challenges are presented and discussed in turn.

Source owners and particularly the resident users are confronted with difficulty or problems associated with non-residents users, NRU. The difficulty represents a critical menace to the source management. Table 9-4 reveals that about half (49%) of the 33 respondents complained about the source management problems engineered by the non-resident users.

The problems associated with non-resident users are twofold (Table 9-4). Ten (or 63%) of the 16 users who reported the menace caused by NRU decry the destructive tendencies of non-resident users. Six (or 37%) of the 16 respondents described the problems with access control. In Box 9-6 strong negative comments like *'the people around are very wicked. They broke the cover and damage those things'* are used by respondents to qualify the problematic activities of the NRU (R39). One of the respondents also observed '*See, the construction was done recently. The people of this neighbourhood just derive pleasure in destroying things*' (R40). And another summarised her experiences with NRU by disclosing '*This neighbourhood is terrible it is a school and within a year of living here I have learnt lessons of life*' (R1).

Three objects of destruction are noted in Box 9-6. The objects are the wellhead cover, bucket and rope, and the well area. Invariably the respondents noted damages to well cover, damage and/or carting away of bucket and rope, and misuse of the well area. Also from Box 9-6, three consequences of damage to well cover are noted. The consequences are conflict between source owners and resident users over asset control (R1). Usage of hand dug well water restricted to non-drinking purposes (R42). And stoppage of well cover provision or repairs (R90).

Table 9-4: Challenges to hand dug well management

	Challenges to source management	Frequency	% Frequency
1	Problems of non-resident users	16	49
	▪ Destructive tendencies	10	
	▪ Difficult access control	6	
2	Lack of co-operation between owners and resident users	7	21
	▪ Conflict on source maintenance	5	
	▪ Conflict on access control	2	
3	Unhygienic behaviour around the wells	4	12
4	Lack of co-operation among resident users	3	9
5	Problems of children as source operators	2	6
6	Recovery of loose buckets	1	3
	Total	33	100

The influence of damaging and/or carting bucket and rope away is also reflected in Box 9-6. The comments made by R1, R4 and R62 explained why usage of multiple buckets is common practice '…*what makes individual to have their own bucket is that most people are careless when using it and it* (the bucket) *may drop into the well'* (R4). '….*people when they come for water sometimes goes away with the bucket'* (R62). Still on the usage of multiple buckets R76 queries that '….*how can I allow anyone to use what I bought with my money anyhow*?' The respondents are particularly opposed to the usage of dedicated bucket mainly because of the menace created by NRU. Usage of multiple buckets is earlier discovered to be a very high risk water safety threat to hand dug wells in the study area (Table 7-5).

Figure 9-2 captures the abuse to the well area reported by R51 in Box 9-6.

Figure 9-2: Abuse of well area

The second major challenge to source management has to do with lack of co-operation between source owners (SO) and resident users (RU). Twenty one percent of the respondents presented in Table 9-4 spoke about the challenge.

Box 9-7 shows that source owners exercise right of ownership on access control (R1 and R78). And resident users show recognition of their non-ownership status by shying away from asset repairs and maintenance.

Damages to wellhead cover

R_8:	*On several occasion they have broken and removed the zinc cover on the well.*
I:	*So you are saying that there is no way that you owners can handle this people?*
R_8:	*There is no way.*
I:	*But I think we should be able to control them.*
R_8:	*We may be able to control people within the house what about the outsiders, particularly during dry season when there is no tap water, how many people are we going to talk to?*
R_{39}:	*'… but the people around are very wicked. They broke the cover and damage those things.*
R_{40}:	*See, the construction was done recently. The people of this neighbourhood just derive pleasure in destroying things.*
R_{42}:	*It's our people; some of them are bad, they broke the cover; that's why we stop using the well water for cooking and bathing.*
R_{90}:	*'… users hardly ever allow cover to stay on the well. Any time the well cover is fixed, by the night, it is removed, so we stopped providing cover for the well.*

Problems with Buckets

R_1:	*It is not that we cannot tie a drawer to the well but the people around here are destroyers; they are destructive. It is good as you said it but if we tie one there they will use it badly.*
R_4:	*What makes individual to have their own drawer is that most people are careless when using it and it may drop into the well.*
R_{62}:	*That is what I have been doing but people when they come for water sometimes they go away with the drawer*

Problems with Well area

R_8:	*'….some after fetching water will turn it down here on the ground and if we complain they would say that it will flow away'*
R_{51}:	*We have talked so much but our people are not yielding. I however feel that if the government comes in now and arrest some people all this throwing and dumping of refuse will stop. We are not police or sanitary inspector; there is nothing we can do. We have been arrested before and if they (the police) come again we shall take them (the police) to every of their (refuse dumpers) door steps.*

Source: Research interviews; I: Interviewer; R: Respondents

Box 9-6: Non-resident users: major challenge to hand dug well management

R_1:	*We have done it before, the landlord instructed us to be locking it….when we took action based on what he said and the people rebelled, he still shifted the blame on us. He said did we rent the house because of water?*
I:	*Ok, what can you do if your reason for not drinking the water is because of what people are throwing into the well to fetch water? What can you do to control that?*
R_{78}:	*There is nothing we can do except to repair the cover and we can not ask them not to fetch water because the landlord will allow them*
R_{17}:	*As tenants there is nothing we can do. We can't do it on our own*
I:	*What about if you talk to the landlord?*
R_{18}:	*We have about 4 landlords in this place. What I will say is that let every man fetch his water and treat it. If you come back in the next 3 years you'll meet the well the same way it is now.*
R_{34}:	*I can agree with you but if we tell the Landlord this water is not good, he will not do anything.*
I:	*Is the Landlord living here?*
R_{34}:	*No*
I:	*You are the one living here and using the well can't you call yourselves together?*
R_{34}:	*It is not possible*
I:	*I understand that it is not your water because you are not the owner but you use it any way and since you use it, you and not the landlord is been affected by the water….*
R_{34}:	*Yes it's not affecting the Landlord*
I:	*Then are you going to do something about the well?*
R_{34}:	*Do you people want to help us to repair it?*
I:	*It is the same thing I said about the Landlord. We do not live here, so it is not our responsibility to do anything shouldn't you be able to repair it?*
R_{34}:	*I can not agree who will pay and repair water for the landlord?*
I:	*Does everybody see repairing of well as the landlord's duty?*
R_{34}:	*Yes, I ask someone to contribute to repair light (electricity) and he told me that there is no electricity in the village, he can do without electricity!*

Source: Research interviews; I: Interviewer; R: Respondents

Box 9-7: Remarks reflecting lack of co-operation between source owners and resident users

Twelve percent of the respondents presented in Table 9-4 highlighted the third challenge to hand dug well management in the study area. The challenge involves the supervision of hygiene behaviour around the well. Users perform many of the water related household activities close to the source of water. Examples include laundry, bathing, and toileting activities (Box 9-8). Box 9-8 also reveals that poultry pen, litters and refuse drops are common sights within well areas.

The four respondents that reported hygiene management problems are resident users. In Box 9-8, the comments of three (R19, R20, and R41) of the four respondents imply that maintaining the well area is the responsibility of the resident users. The fourth respondent (R51) however attributed the un-kept state of the well area to non-resident users. Invariably, where there is no co-operation among resident users coupled with in-ability to control the activities of non-resident users, source management relating to hygiene behaviour near the wells become a serious challenge.

Also by implication, apart from access control, hygiene management represents another arm in hand dug well (source) management.

R_{19}:	*Why I ask you to be called is that this place nothing should be washed here (the well area). In my own space I know that my hens sleep over there and I have decided that they will be moved away. If I do that, then this container also should be removed. And also we should clear this (the well area) place.*
R_{20}	*It is for the benefit of all we would make an end of it, all this rubbish must be parked away.*
R_{41}:	*When you saw me this morning trying to sweep and tidy the well area, it is not that I knew that you were coming. It is just something I have made my responsibility. I left it (well area cleaning) because of the careless use of the residents. Just yesterday again, I did thorough cleaning and this morning the whole place is all mess. Before I swept this place this morning, you would have asked if people that live here are able to sleep. A relative of the owner came around sometime ago wondering why the whole area is left un-kept. I told him that I purposely left it for him to see. You will find excretes and urination almost everywhere.*
R_{51}:	*On the environment I've told you that there is nothing we can do, but when you come again, if you want to talk to those who are using this place I can take you to their houses and whatsoever you want to say you can say it to them directly.*

Source: Research interviews; I: Interviewer; R: Respondents

Box 9-8: Hygiene behaviour around well area

The fourth challenge to the management of hand dug wells is attributed to the lack of co-operation among resident users. This challenge is reported by three respondents (Table 9-4). Referring to Box 9-8 and with additional evidence in Box 9-9, lack of co-operation among resident users makes hygiene management a particularly difficult task. Hygiene management is particularly difficult because resident users' exhibit different hygiene levels (Box 9-9). Different hygiene levels are informed by different water use priority for hand dug well water. The influence of water use priority on hygiene levels is discussed further below.

In Box 9-9, while some resident users try to take the hygiene responsibility for well areas (which represents a common or joint owned area); other resident users either discredit such hygiene initiatives or discourage such individual effort. For instance R41 explained that '*I take it as my job to do so* (*clean our surroundings*)*….some people just live in the house, they claim that they cannot sweep…*' In another instance R75 believes that the success of source and water safety initiatives hinges on co-operation among resident users ('*…. if others will co-operate*) but noted that such co-operation is presently lacking (Box 9-9). Lack of co-operation as noted in particular by R75 may thus have grave implication for water safety plans.

R_{40}:	*'…our neighbour here fight me over the well that's why I left the well unattended to. I know that everybody knows that I have tried in getting them (residents) to do the right things about the well, but they do not comply*
R_{41}: *I:* *R_{41}:*	*'To make our surroundings clean is something that we want, I take it as my job to do so. We were taught to wake up in the morning and clean our surroundings and we do so, but nowadays, some people just live in the house, they even claim that they can not sweep, pride that will not get them anywhere...* *So, there is no way that you can agree* *No way*
R_{75}:	*'…. if others will cooperate, and will not accuse others of anything, because if a person does it, it may be a problem on him/her. Like when my husband ask one of our co-tenants to close the gate one night, the person refused to answer my husband that night that it really turned to a big problem. I expected the landlord to come out and judge the case, he didn't come out at all instead he went to the other party who is wrong and started begging them.*

Source: Research interviews; I: Interviewer; R: Respondents

Box 9-9: Respondents comments reflecting lack of co-operation among resident users

The seriousness of the implication of lack of co-operation among resident users on water safety plans is rooted in two factors. The first factor is that shared residential houses are common practice in the study area. Shared houses come either as blocks of flats or as blocks of single unit rooms. The most common however are blocks of single unit rooms. The second factor, which is inferred from the first factor, is that resident users will usually be a significant stakeholder in hand dug well management. As noted by R75 therefore, there is the need to seek co-operation among resident users on source management to ensure source and water safety plans of hand dug wells.

It should however be noted that the need to seek co-operation among resident users for hand dug well management represents one of the unique management features of self supply systems. That is systems owned by one but managed by many. This management feature is different from communal systems – owned and managed by the community. Or the public water systems, which are owned and managed by the Government. The involvement of resident users in hand dug well management should therefore be given the unique and the appropriate consideration it deserves in the development of water safety plans for self supply systems.

The fifth challenge to source management is the problem of children as source operators. In Table 9-4 four interviewees observed hand dug well operation by children as a problem. The respondents comments presented in Box 9-10 suggest that:

- Children as hand dug well operators are a common feature in the study area (R78, R82 and R86)
- Children abuse hand dug wells (R41, R78 and R82)
- Children play around wells (R86), and
- Prevention of children as well operators is considered a safety measure in terms of human, source and water safety (R82 and R86).

Three important points can be made from the above observations. The first point relates to child well operators as common practice. The second identifies the children operation activities that require supervision or control. And the third involves access denial for safety reasons.

The observation made - children as well operators a common practice - corroborates established knowledge. Loughran and Pritchett (1997) remarked that children often have an important role in performing household tasks such as water collection. Guarcello et al. (2004) also noted the responsibility of children as water collectors in five different countries of the world. Observations made in the field studies for this research also confirm that children as well operators or water collectors are common in Abeokuta.

Identification of children activities, which require control, is however critical to hand dug well management as well as to hand dug well water safety. For instance the '*…dirt in water*' mentioned by both R41 and R82, and bucket misuse reported by R78 in Box 9-10 shows that children operation activities represent one of the critical operation actions around hand dug wells. Bucket related activity is particularly critical because bucket related threat represents a very high risk problem to hand dug well water safety (Table 7-7). Critical operation activities by implication deserve critical control actions. Children operation activities with hand dug wells therefore represent very high risk and a critical control point in hand dug well management and water safety plans development.

To deny children access to wells for safety reasons is debatable. On the one hand, human, source and water safety are good grounds to deny access to wells. Denying children the access to wells may not however be a feasible or sustainable source management option. Denying children the access to wells may not be feasible because of the generally perceived role of children as water collectors (Loughran and Prichett, 1997; Guarcello et al., 2004). Consideration of setting a minimum age limit for hand dug well operation may however be a meeting point between the two sides of the argument. The recommendation of minimum age limit should nonetheless be tested with water users prior to any possible adoption or implementation in source management and water safety plans.

$R_{41:}$	*'….because I scolded a child for being dirty with the water….'*
R_{78}:	*'…but you know the children, they will loose the bucket into the well. When they fetch too much water, they will throw the bucket into the well and they will also try to get the bucket out by themselves when no one is at home*
R_{82}:	*The cover was spoilt by the rain so children are not allowed to fetch from the well to prevent dirt in the water.*
R_{86}:	*'…. We also prevent children from fetching or playing by the well side*

Source: Research interviews; I: Interviewer; R: Respondents

Box 9-10: Children as hand dug well operators

Bucket recovery problem is identified by R78 in Box 9-10. R78 noted that '*but you know the children… they will throw the bucket into the well and they will also try to get the bucket out by themselves when no one is at home*'. The remark suggests that the problem of bucket recovery is associated with children operation activities. The remark also suggests that there is no standard bucket recovery tool made available to children.

Unavailability of standard bucket recovery practices is not verified in the research. Figure 9-3 however shows a bucket recovery exercise witnessed by the researcher at one of the selected wells. In Figure 9-3 a long wooden plank with nails attached was used to recover a loose bucket from a well.

In the event that there is no standard bucket recovery tool or system, development and usage of standardised user friendly bucket recovery tools and practices is recommended for hand dug wells with bucket system operations.

Figure 9-3: Bucket recovery exercise

9.4 Factors Fuelling Source Management Challenges

Challenges to source management are influenced by four factors. The four catalysts are:

- Insult (name calling) from non-resident users
- Perception of water as common good
- Absence of source owners or property care taker, and
- Water use priority

Four respondents communicated the impact of insults on source management activities (Box 9-11). All four of the respondents were resident users. Offensive words like '*crazy*' (R41) and derogatory statements like '*you are tenants (rent paying occupants) when you are ejected (by property owners) carry the well along with you'* (R1) are examples of the abusive language that represents insults to the intended.

The respondents described two source management efforts which were started but eventually discontinued due to name calling (Box 9-11). R1 cited access control via locking of well while both R40 and R41 described stoppage of hygiene management efforts. Insults or name calling by non-resident users also discourage the resident users from further getting involved with source management initiatives (Box 9-11).

From Box 9-11 therefore, the consequences of insults or name calling are twofold. Firstly, insult is capable of driving source management initiatives and invariably water safety plans activities to a halt '*….but the bad word from people prevented us from locking it further'*. Secondly, key source management personnel may be deterred from management functions '*I am sorry but on the case of this water; I do not guarantee its safety in my hands. The insults are too much and think of the fact that it is for their safety*'. Resident users were earlier identified as hand dug well managers (9.3).

The consequences of name calling suggests that passing insults to source managers is a limiting factor to source management and by implication to water safety plans. Name calling by the control groups in hand dug well management also signify a social hazard to contain. The social hazard should not however be allowed to derail source management and/or water safety plans.

The second factor; water perceived as common good is indicated by four respondents (Box 9-12). R87 claimed that *'…the well is free for all'*. According to R88 *'….the landlord constructed the well for public use'*. Equally R1 declared that '*We do not hoard water or keep people away from the well*'. And the fourth respondent (R84) said access to well water is free because '*water is a natural resource*'.

An observation that is common to the remarks of the four respondents is that free access is tied with perception of water as a common good. Free access to hand dug wells encourages limited or no management practice.

R_1:	*We have done it before, even the landlord instructed us to be locking it then but the bad word from people prevented us from locking it further*
R_2:	*They said, 'you are tenants when you are ejected carry the well along with you' those are their words.*
R_{40}:	*They always abuse us if we complain of their bad usage.*
R_{41}:	*It has been war over the well. With all what we did the other time the well was repaired, they made it very difficult for us and insulted us throughout. The caretaker's wife did a lot when we complained about their hygiene but they destroyed everything.* *There was a situation, which resulted because I scolded a child for being dirty with the water, he went and called his father. The old man opposite called me a crazy woman and I had to ask him to stop insulting me. I explained that my concern for the well is for everybody's benefit and not only for myself, but they do not appreciate it. This other woman too takes everything negatively. She once told me that 'where are the well owners, are they not all dead' (implying that you don't need to kill yourself over what you do not own)!* *I am sorry but on the case of this water, I do not guarantee its safety in my hands. The insults are too much and think of the fact that it is for their safety*

Source: Research interviews; I: Interviewer; R: Respondents

Box 9-11: Name calling by non-resident users

Another observation is that the four respondents presented in Box 9-12 are resident users. The statement of R88 '…*the landlord constructed the well for public use*' however suggests that the perception of the source owner equally aligns with that of the resident users.

Two possible problem scenarios may result. In the event that source owners and resident users share the same perception of water as a public good as indicated above, the source may be in danger of limited or no management. Where owners and resident users however share contrasting views on water as public good, source management may lead to conflict between the named parties.

A limited or no-management approach would not ensure safe water. Conflict between source owners and resident users would not impact positively on source management and/or water safety activities. Either way, appropriate enlightenment is necessary to mitigate the influence of water a common good on source management and invariably on water safety plans.

I:	*Did people yield to your instructions on the well?*
R_1:	*No they did not*
I:	*Why, don't you lock it up?*
R_1:	*We don't hoard water or keep people from the well*
I:	*Who authorizes access to people from outside?*
R_{84}:	*No one really*
I:	*Why is that?*
R_{84}:	*Because it is a natural resource*
I:	*Who do the people seek permission from to use the well?*
R_{87}:	*No one, the well is free for all*
I:	*What about the landlord, does he live here?*
R_{87}:	*He does but the well is left for any one who wants water*
I:	*Are they all rightful users of the well?*
R_{88}:	*We can say that because the landlord constructed the well for public use*

Source: Research interviews; I: Interviewer; R: Respondents

Box 9-12: Water perceived as common good

The third factor is concerned with the absence of source owners. The factor is reported by three respondents (Box 9-13). Absence of source owners is engineered in two ways; absence as a result of non-residency (R33 and R34) or via the demise of the source owner (R41).

Aside from the source owners, the remarks of R33 and R41 reveal another actor in hand dug well management - the caretaker (Figure 9-4). The remarks '*it is the caretaker that comes here to collect money, the landlord and his son may not come for months*' and '*The only person who used to be in charge after the death of the owner are the traders in the shops opposite us*' suggest that caretakers are assigned representatives of property owners, invariably source owners. And the duties of caretakers include rent collection and asset (property and water source) management. Asset management will hereafter be used interchangeably with source management.

R_{33}:	*There is always this type of problem in a house where the Landlord is not staying with them. It is the caretaker that comes here to collect money, the landlord and his son may not come for months. We are many here. Any house which is not a flat is difficult to manage.*
R_{34}:	*'…if we tell the Landlord this water is not good, he will not do anything.*
I:	*Is the Landlord living here?*
R_{34}:	*No*
I:	*You are the one living here and using the well can't you call yourselves together?*
R_{34}:	*It is not possible*
I:	*I understand that it is not your water because you are not the owner but you use it any way and since you use it, you and not the landlord is been affected by the water….*
R_{34}:	*Yes it's not affecting the Landlord*
I:	*Then are you going to do something about the well?*
R_{34}:	*I can not agree who will pay and repair water for the landlord?*
I:	*Does everybody see repairing of well as the landlord's duty?*
R_{34}:	*Yes, I ask someone to contribute to repair light (electricity) and he told me that there is no electricity in the village, he can do without electricity!*
I:	*What about the owner?*
R_{41}:	*The owner is dead*
I:	*Is there no one who can take responsibility for the well?*
R_{41}:	*The only person who used to be in charge after the death of the owner are the traders in the shops opposite us, but she is also dead and the shops have been taken over by new tenants. We the residents are supposed to look after the well now*
I:	*So can't the resident users agree on taking proper care of the well?*
R_{41}:	*At all; the people of this neighbourhood do not agree on anything that will benefit them*

Source: Research interviews; I: Interviewer; R: Respondents

Box 9-13: Impact of the absence of source owners on source management

The views of the respondents in Box 9-13 again reveal that in the absence of the source owner and/or the caretaker, asset management reverts to the residents '*We the residents are supposed to look after the well now*' (R41).

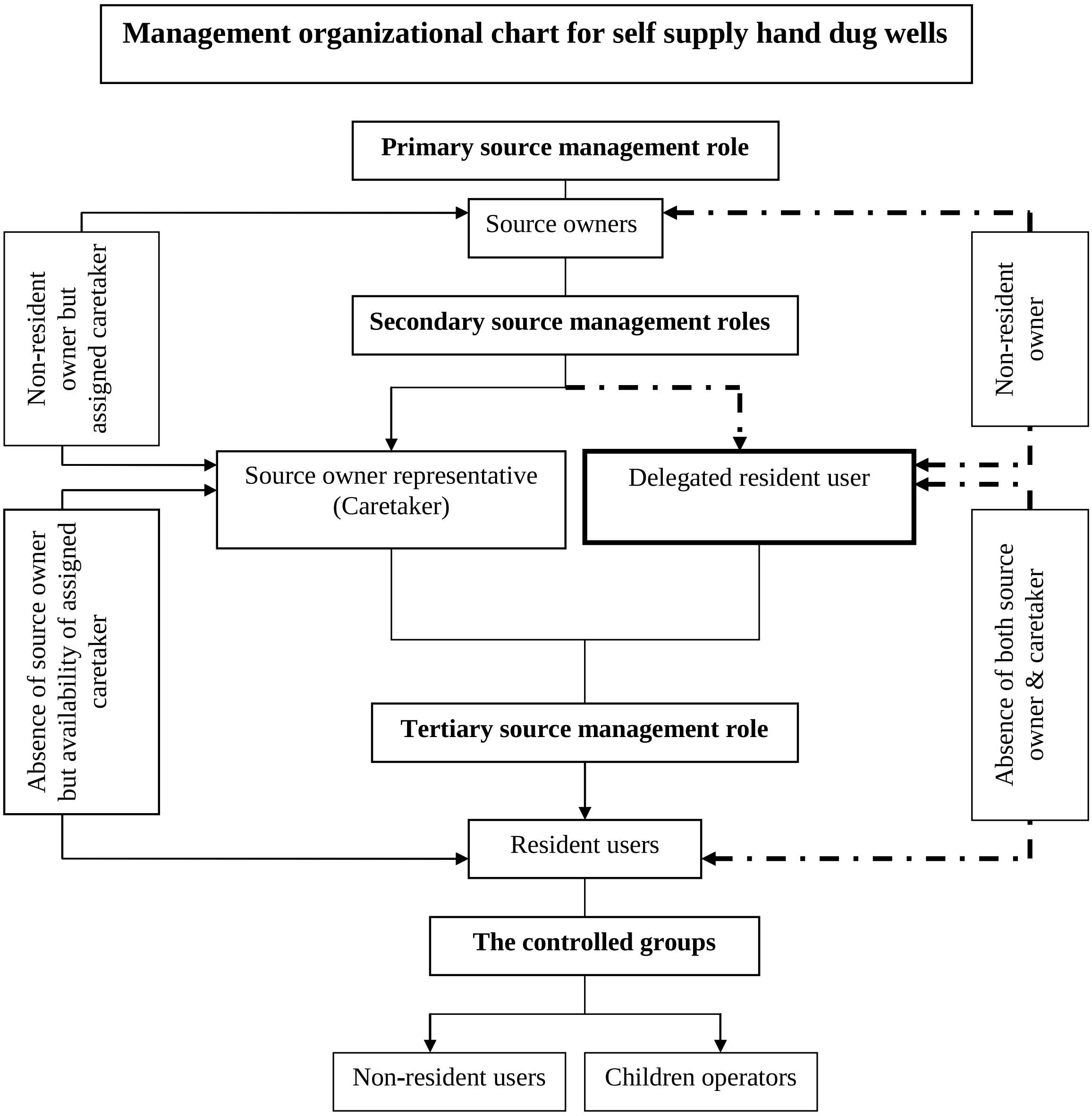
Asset management by residents however is difficult because '*We are many here. Any house which is not a flat is difficult to manage' and 'the people of this neighbourhood* *do not agree on anything that will benefit them*'. Furthermore the residents '*do not agree*' because according to R34, '*I cannot agree, who will pay and repair water for the landlord*?' The above comments points to two inter-related problems involving the difficulty of managing many residents, and the problem of lack of consensus.

From the statement of R34, reaching a consensus among many resident users in the absence of source owner is difficult. Difficult management is therefore a function of lack of agreement as residents see asset management as the responsibility of the owners. To regard source or asset management as the responsibility of the source owner is however a perception rooted in ownership. Source ownership status dictates where the primary source management role lies, and that is with the source owner (Figure 9-4). Source ownership thus represents a key factor in self supply system management.

Another management difficulty is identified from the comment '*We are many here. Any house which is not a flat is difficult to manage…*' When source management becomes the responsibility of the resident users, the problem of a source with many managers ensue. This management difficulty suggests that in the absence of the primary owner and/or the secondary owner (primary owner representative/caretaker) source management role become un-delegated as the role reverts to the resident users.

Absence of source owner and/or owner representative thus exposes the result of un-delegated management role in source management on one hand and the ownership responsibility on the other hand. In the absence of source owners and/or owner representative therefore, delegated source management may be the answer to achieve consensus or cooperation among resident users (Figure 9-4).

As pointed out earlier, absence of source owners is generated in two ways: non-residency or demise. In the event of a non-resident source owner, the delegated resident user may be required to liaise with the source owner. In the case of the demise of the source owner and/or unavailability of any secondary owner, source management responsibility reverts to resident users but under the supervision of a delegated resident user (Figure 9-4). Consideration for delegation may however be based on voluntary appointment or the resident user with the longest tenancy.



NB: The highlighted box is a recommended role. The broken arrows are recommended links

Figure 9-4: Management organizational chart for self supply hand dug wells

The fourth identified influencing factor on source management in the study area is the water use priority. The priority that any user assigns to water from a particular source can be linked to the hygiene behaviour the user exhibits around the source. The link between water use priority and hygiene behaviour is illustrated in a source management feud recounted by R41. '*It has been war over the well. With all what we did* (to repair the well), *they made it very difficult for us and insulted us throughout. A woman once told us that* '***we are the ones using the water for cooking, she only uses the water for laundry***'*; they never agree on something good in this area*'. A user who sees water from a dug well to be good enough for only non-ingested purposes will not, for example, hesitate to draw water with an un-kept bucket and rope. The reverse may however be the case, if the source is the drinking water source.

Water use priority is a function of the perceived source water quality (6.2.4). The influence of water use priority on hygiene management can thus be eliminated or at least be minimised if safe water quality is ensured. Safe water quality of hand dug wells can however be ensured through water quality management or essentially through the development of water safety plans.

9.5 Source Maintenance and Improvement Measures

Respondents are able to identify nine source maintenance and improvement measures. Five of the nine measures are however mentioned more often than the other measures. All the measures are listed below with the corresponding frequency of mentioning in parenthesis:

- Re-digging of well hole (13)
- Well cover repairs (5)
- Source water treatment with chemicals (5)
- Maintenance of well area (4)
- Provision of dedicated bucket (2)
- Installation of well lining (1)
- Cleaning of well hole (1)
- Pump repairs (1)

- Education of resident users (1)

Hand dug well re-digging is the most common form of source improvement. We '*re-dig the well and pack the dirt out*' represent the most frequent response to the question on source maintenance. The '*dirt*' refers to both debris and sedimentation. Well cover repair is the second most frequent improvement measure. Damage to well cover is associated with the destructive tendencies of especially non-resident users.

Source water treatment is also fairly popular with hand dug wells in the study area. Four of the five respondents presented in Box 9-14 specified the use of alum for source water treatment. The practice is to '*pour alum in large quantity into the well*'. Two other specified forms of treatment are the use of Water Guard and chlorine. Water Guard is a brand name for hypochlorite packaged for household water treatment.

The danger identified with the practice of source water treatment with chemicals lies in the dosage. R86 for instance recounted '*what I noticed was that the water foams when you put it to boil as if you added soap into the water. And many times, the chlorine is too much. We figured that the dosage was not proportionate to the water quantity. So we asked them to stop coming to treat the well. It however took two years before the effect of the chemicals wore off, ever since; we stopped making any effort to treat the well*'.

Source water treatment involving the use of chemicals like chlorine is arguably expected to be carried out under the supervision of or with the instruction of skilled personnel. Use of chlorine in the form of hypochlorite packaged in brands like Water Guard specifically for household purposes is however recommended. Water Guard is nevertheless intended for household water treatment rather than source water treatment.

Maintenance of well area refers to '*sweeping or clearing of the well area*' (3 respondents), and/or '*cut down of tree*' around the well (1 respondent). Well lining and re-digging are improvement activities, which are season based. R39 explained that '*I plan to get the rings but it has to be during the dry season. As you know we have to get the water out before we can do that. It will be easier that way for those who will work on it. They will also get the dirt out (re-dig)*'.

Cleaning of well hole, contrary to getting dirt (sedimentation) out by re-digging involves '*people to enter the well to clean the inside; the well is lined with cemented block lining, this makes it easy to clean and the well is not deep at all* (0.9 m)'. Pump repairs also require people to enter the well but in this instance to repair the pump. '*We called the repairers who enter the well to repair the pump* (motorised pump suspended within the well but above water) *and at times we call the electrician when the pump engine is burnt*'.

Dedicated buckets are replaced when '*after some time the rope became weak and cuts*'. While R61 believes that education of resident users on how the source could be managed is a better source improvement strategy. He suggested '*I can try to educate them on how the well could be monitored, may be in one of our tenant meetings*'.

R$_{81}$:	'…. And we poured some chemicals into the well
R$_{83}$:	*The water was dirty when the well was first constructed. We bought alum and poured it into the well*
R$_{88}$:	*At times the well water will be coloured that is why we do add alum to the water*
R$_{93}$: *I:* *R$_{93}$:* *I:* *R$_{93}$:*	*I use water guard or alum* *Oh, you know about water guard?* *Yes, I know water guard* *What is the difference between Water guard and alum?* *Water guard is a chemical that is well measured while alum is one aspect of treatment!*
R$_{96}$:	*'We use to call some retired officers from the Water Corporation to treat the water. They normally pour alum and chlorine in large quantity into the well. But what I noticed was that the water foams when you put to boil as if you added soap into the water. And many times, the chlorine is too much. We figured that the dosage was not proportionate to the water quantity. So we asked them to stop coming to treat the well.* *It however took 2 years before the effect of the chemicals wore off. Ever since, we stopped making any effort to treat the well.*

Source: Research interviews; I: Interviewer; R: Respondents

Box 9-14: Source water treatment practices

There are however five prescribed source improvement conditions that need to be met for maintenance to be achieved. The conditions with corresponding number of respondents are:

- Agreement between users (3)
- Maintenance cost contribution by resident users (2)
- Funds availability (2),
- Seasonality - season dependent maintenance works (2), and
- Adequate power supply – source maintenance based on availability of (electric) power (2)

Three respondents believed that consensus '*agreement between the people*' especially between the resident users is a precondition to source improvement. And consensus could only be reached if '*we all sit and talk about the care of this well*'. According to two other respondents a major point to agree on is the maintenance cost contribution. A precondition that is rather difficult to achieve '*all the neighbours will have to pay for the cover* (R11)' but '*it will be difficult to ask our people to contribute money*' (R12). Another related precondition is availability of funds. According to R47 '*the owner's major complaint is about getting the money to do the repairs. We are going to do it but not now*'. Fund availability condition is however justified by R79 who claims that '*Fingers are not equal. People do not have the same financial strength*'.

Some well maintenance activities are best carried out in the dry season thereby making seasonality a precondition for the relevant source improvement actions. Examples of the season based improvement activities are well lining and re-digging. Two respondents particularly recognised that the major problem with hand dug wells is low water level or complete dryness during the dry season. R93 noted that '*The well has seasonal problem*' and R94 corroborates '*the water is usually dry during the dry season*'. The identified well problem is however best resolved in the specified season.

The last referred precondition is availability of power source. Source improvement works like the repairs of metallic well cover requires welding. Welding works are usually based on the supply of some form of power. Electricity generated power represents the most common source of power in the study area. The supply of the power source is however very erratic. R74 confirms that '*Right now we are having light (electricity power) problem and I think that's what's holding the repairs*'. And R78 in support remarks that '*you know how the light (electricity power supply) is so erratic. No one can do any tangible work or repairs under the situation*'.

9.6 Specified Roles and Responsibilities

The summary of the specified roles and source management responsibilities identified in the results and discussions within the chapter is presented below:

Roles/Responsibility	Actors
Supervision of access to hand dug wells	Resident source owners (RSO)
Introduction of well management rules	RSO
Enforcement of well management rules	RSO or delegated resident user
Source maintenance	RSO or shared responsibility of resident users in the event of deceased or non-resident source owner

9.7 Implications of Source Management for Water Safety Plans

Access and hygiene management are identified as the basic source management approaches adopted for hand dug wells in the study area. Access to hand dug wells is however managed in five ways. Access management through tap stands or key collection practices, operation time management, supervision condition-based method, and event based access management option. The critical control groups are the children and the non-resident users.

The summary of the access management options identified from the existing practices are outlined below. The management options can be adopted and included in the water safety guidance for self supply hand dug wells:

- Install pump (dedicated and motorised) in well and allow dedicated 1 to 2 tap stands for NRU. This represents the best available practice.
- Keep well under lock and key with absolute non-access to NRU.
- Keep well under lock, but allow access during owners/RU time of operation. RSO and/or RU can then supervise operations and other operators.
- Keep well under lock but allow monitored access through key collection and return.

The challenges confronting self supply well management in the study area are diverse with varied implications for source management and water safety plans. The need for resident user co-operation generated from the problem of lack of co-operation among resident users however describes one of the unique management features associated with self supply systems. Recognition of this uniqueness is crucial and vital for water safety plans development for self supply systems. Recognition of the unique management feature also justifies the need for appropriate water safety plans for self supply sources. The existing WHO water safety plans expects the management and especially the development of water safety plans to reside with water providers. Water providers in the context of self supply systems are source owners. Resident users are however key stakeholders in self supply system management.

The various source management challenges suggest the need for modification of existing access control and hygiene management strategies. The following new concepts are therefore recommended by the author:

- Introduction and display of source access time-table and operation rules
- Introduction and enforcement of the usage of dedicated bucket and rope
- Introduction and enforcement of minimum age limit
- Enforcement of operation rules through sanctions such as banning the usage of un-authorised bucket
- Introduction of supporting programs: training of SO and/or delegated RU on how to set up and enforce source and water safety rules.
- Introduction of government regulation to enforce source management. Government regulation is suggested by three of the 60 respondents in Figure 9-1.

The listed recommendations are discussed further in Chapter 10.

10 USER PERCEPTION OF PROPOSED CONTROL MEASURES

A number of access control and hygiene management strategies are identified in chapter 9. There are suggestions to modify some of the identified control measures. A few new control measures resulting from the existing source management challenges are also recommended by the author (9.7). These control measures were tested in the second field study of the research to verify the feasibility and/or acceptability with water users (4.6.2). Acceptability of the control measures is presented and discussed in this chapter. The result also reflects the fourth objective of the research, which is the evaluation of control measures.

10.1 Acceptability of Identified Control Measures

The views of fourteen respondents were sought regarding the possible introduction of twenty control measures for hand dug well management to ensure water safety (Table 10-1). The number of responses for each control measure varied from 9 to 14. In a few instances, related control measures were grouped. For example views on control measures 13 to 16 associated with household water treatment and hygiene were given as being related. At least 12 responses were obtained for each control measure (Table 10-1).

From Table 10-1, respondents are either for (Y) or against (N) a measure while a few claim acceptability based on specified pre-conditions (C). Acceptability of the highlighted control measures are presented and discussed in turn.

Table 10-1: Acceptability and specified actors for recommended hand dug well (source) management control measures

	Control measures	Frequency			Actors									
		Yes	No	C	Government						LLA	SO	RU	Others
					Federal		State	Local		NS				
					MOH	MAWR	WB	LGC	PHD					
1	Standardised well construction design	3	8	3	-	1	1	1	2	2	1	-	-	-
2	Dedicated pump installation	0	13	1	-	-	-	-	-	-	-	-	-	-
3	Cleaning of well area	10	1	2	1	-	1	-	3	1	1	2	2	2
4	Minimum distance to source of waste	6	1	3	1	-	1	-	2	4	1	-	-	-
5	Usage of dedicated bucket	5	2	2	-	-	-	-	1	1	-	2	1	1
6	Minimum age limit	9	2	1	1	-	1	-	1	1	1	-	-	1
7	Source hygiene management rules	13	0	0	-	-	1	-	1	2	-	6	2	1
8	Sanction of un-ruly behaviour	12	1	0	-	-	1	-	1	2	-	6	2	1
9	Display and compliance with access time	10	1	3	-	-	1	-	-	3	-	6	1	2
10	Access time supervision	10	1	3	-	-	1	-	-	3	-	6	1	2
11	Lock well when out of use	9	2	3	-	-	1	-	-	3	-	6	1	2
12	Standard bucket recovery system	10	1	3	-	-	1	-	-	3	-	6	1	2
13	Household water treatment policy	4	3	3	1	-	-	-	-	1	-	-	-	5
14	Hand washing before storage usage	3	4	3	1	-	-	-	-	1	-	-	-	5
15	Usage of in-house storage cover	3	4	3	1	-	-	-	-	1	-	-	-	5
16	Usage of in-house storage bailer	3	4	3	1	-	-	-	-	1	-	-	-	5
17	Monitoring of water quality status	1	3	7	-	-	-	-	-	6	-	1	-	1
18	Inspection of well handling & hygiene	1	3	7	1	-	-	-	-	6	-	1	-	1
19	Regulation of source management	1	3	7	1	-	-	-	-	6	-	1	-	1
20	Compulsory supporting programs	6	1	4	1	-	-	-	-	7	-	-	-	1

N = 14; MOH: Ministry of Health; MAWR: Ministry of Agriculture and Water Resources; WB: Water board; LGC: Local government council; PHD: Public Health Department; NS: Not specified arm of government; LLA: Land lords association; SO: Source owners; RU: Resident users; C: Conditional; Others: Head of household, any sensible adult, caretaker, NGO, Universities; -: Nil

10.1.1 Standardised hand dug well construction design

The first control measure is associated with hand dug well construction. The measure is the introduction of a standardised design for hand dug wells. The well construction standard is to include construction design and quality of construction materials.

Thirteen respondents remarked on the first control measure. Three respondents are in favour of the introduction of standardised design for hand dug well structure. Another three respondents suggested a pre-condition for acceptability of the measure while eight respondents are completely against the measure (Table 10-1).

The respondents in favour of standard well construction design opined that the measure would bring about three positive impacts. Well water would be used for all household purposes, improved hygiene within well area, and 'better' (in terms of quality) water. The users equally suggest the state, the local government council or the property owners association (Land lords association, LLA) as the best possible implementers of the control measure (Table 10-1). The LLA are expected to influence the usage of approved design among source owners (also property owners) within the associations.

Two pre-conditions are mentioned by the users in the C category. R84 opined that introduction of standardised well construction design is feasible '*for those who can afford it*'. R96 claimed '*only with new wells*'. R89, a source owner stated '*I will not dig a new well*'! Invariably, the users do not see the possibility of owners of existing wells complying with a measure that suggest re-construction or construction up-grade. And affordability is seen as a limitation with either reconstruction or building new wells in conformity with standard design.

The number of respondents in the N category suggests that water users generally are not in favour of standard well design. All the eight respondents declined based on affordability (Box 10-1). R90 and R92 claimed that the measure would be '*difficult to enforce*' because of the '*high poverty level*'. Other respondents accede that '*fingers are not equal*' and the design would be '*too expensive*' for source owners to afford.

R88 took the analysis further by quoting the current price of a ring lining as N2, 700.00 (£10.8) per ring. A well lining ring is a pre-cast concrete ring of about 1 m diameter. A 3 m deep well for instance would require up to four rings, three to line the well hole and an additional ring to serve as the wellhead.

The referred '*high poverty level*' is fundamental to affordability and cannot be overemphasised in the context of self supply systems in the study area. However the assumption beneath the '*too expensive*' theory should be queried. The assumption is that the standard design would involve prescription of pre-cast ring lining. And pre-cast ring lining are generally '*too expensive*'. Standard design may not necessarily involve usage of expensive construction material or technique. The drive behind any control measure is safety; human, source and water safety, and not high cost.

The concern for affordability nonetheless suggests that standard control measures that would involve incurring expenses should include a range of design or techniques from best practice[38] to safe practice[39]. Water users are then free to choose within a range of flexible design options according to affordability.

[38] Top of the range in terms of materials and design, for example use of pre-cast concrete ring lining

[39] Not necessarily top of the range but acceptable safe materials and design e.g. cemented block lining

R_{81}:	*Fingers are not equal*
R_{83}:	*'….because of money problem'*
R_{86}:	*Fingers are not equal*
R_{87}:	*Fingers are not equal*
R_{88}:	*'The venture is too expensive the price of ring alone is N2, 700.00 per ring…'*
R_{90}:	*The poverty level in the country can not allow anyone to force anything on anybody*
R_{91}:	*We do not have money the same way*
R_{92}:	*'…it is difficult to enforce, maybe only 50% of the people will comply because of money'*

Source: Research interviews; R: Respondents

Box 10-1: Interviewee responses against introduction of standardised well construction design

10.1.2 Installation of dedicated pumps

The second measure is usage of dedicated pump (manual or motorised) for hand dug well operation. Fourteen respondents commented on pump installation. One respondent gave conditional acceptance, 13 respondents are against the measure, and no respondents spoke in favour of the control measure (Table 10-1).

That there is no respondent in the Y category suggest that usage of dedicated pump for hand dug well operation is generally not acceptable to water users in the study area. All the respondents in the N category do not see the possibility of enforcing usage of dedicated pump because '*of the cost involved*'. R94 the only respondent in the C category equally opined that acceptability of pump installation as a measure would be a function of '*time because of the cost involved*'. And R88 gave the price of motorised pump as N12, 000.00 (£48.00).

Hand dug well operation using dedicated pump is previously identified as best practice control measure for both access and hygiene management of hand dug wells (9.2). The best practice is however rather prohibitive.

10.1.3 Cleaning of hand dug well area

Thirteen respondents spoke about enforcing the cleaning of well area. Ten of the 13 respondents believed that cleaning of well area should be encouraged (i.e. Y category). Two of the respondents agreed with conditions attached while one of the respondents disapproved of the measure (Table 10-1).

R86 and R89, the two respondents in the C category believed that cleaning of well area can only be enforced with wells in a strictly private residence. That is where particularly non-residents have no access to wells. R86 also adds that '*the level of education matters*'. It is understandable that restricted access is mentioned as a pre-condition to the enforcement of cleaning of the source area. The activities of particularly the non-resident users' in hand dug well handling represent a major source management problem. The added comment however suggests the possible influence of '*level of education*' on hygiene behaviour of users.

The influence of the socio-economic status of water users on hygiene behaviour is not within the scope of this research. Study into the possible impact of socio-economic indices on hygiene behaviour and implicitly source management is therefore recommended.

The users in the Y category believed that enforcing the cleaning of well area will achieve four things. The first is promotion of safety consciousness '*makes users think about safety*' (R84). The second is prevention of danger (R87). Danger is clarified by R90 and R96 as diseases and bitter water. R91 cited cholera as an example of disease that needs prevention. The third achievement is that cleaning of well area would minimise contamination. The fourth is to improve health and water quality.

The Y category respondents are unanimous in their willingness to '*abide by the rule and co-operate*' to ensure cleaning of well area. The respondents however differ on who should implement cleaning of source area as a control measure. Five possible implementers are identified in Table 10-1.

The first possible actor is the government. R84 suggested the Water Board or the Federal Ministry of Health as the relevant arm of government to enforce compliance to the cleaning of well area. R93, R95, and R96 however believed that ensuring the cleaning of well area is the responsibility of the Public Health Department (PHD). R95 insisted that the Public Health Workers have been '*trained to educate and enforce compliance*'. Property owners associations, the LLA, are tipped as the second possible implementers while the source owners are next. The other possible actors are the resident users or the heads of households. The heads of households are suggested because according to R90 and R94, household members are obliged to '*listen*' to their instructions.

10.1.4 Minimum distance to sources of contamination

Introduction of a stipulated minimum distance of hand dug wells to sources of contamination is recommended by the author. Proximity to sources of contamination is identified as one of the major water safety threat to hand dug wells in the study area (Table 7-5). The sources of contamination in context include toilets, burial sites, solid waste dumps and untreated waste water drains. Proximity to burial sites is particularly recognised as high risk to wells in Abeokuta (Table 7-7).

Table 10-1 shows that ten respondents argued for a stipulated minimum distance of hand dug wells to sources of contamination. Six of the ten respondents are in favour of the control measure. Three respondents are in the C category while one of the ten respondents is against the introduction of the control measure.

The only respondent in the N category believed that the practice of locating particularly the burial site within or on owned properties is too common a practice to be discontinued. In his words '*…they are so used to burying their dead in this Abeokuta…..and you won't see that happening in other areas*'!

Three limitations were identified by the respondents in the C category. The respondents argued that '*if there is space, yes. If not, no*' (R94). R92 claimed '*not for existing wells*'. And R86 believed that '*it depends on the level of education*'. The limitation of space is relevant and valid. Assets like hand dug wells are located within owned landed area. And owned landed properties are procured based on affordability. Invariably any stipulated minimum distance would be subject to the size of owned landed area.

In respect of limited landed area therefore, provision of public burial area for private or public usage would be appropriate such that the location of burial sites within owned residential lands would be excluded. And the two essential household assets (self supply water source and toilet) would be adequately spaced.

The second limitation, which involves existing wells, is also valid. Existing wells are known to sometimes co-exist with established sources of contamination. Figure 10-1 depicts two instances where hand dug wells co-exist with toilet and public drain (ODO 1), and burial sites with public drain (IDA 1). In particular, nine grave sites are located within 0 – 5.2m of IDA 1, three of which formed a boundary with the well.

Where hand dug wells co-exist with major sources of contamination like toilets or burial sites, a Public Health Officer and one of the key informants interviewed in the research stated that '*…it is the wells that they can close*' (Box 10-2). The suggestion to 'close' the well is equally corroborated by Howard et al. (2003). The authors opined that the relocation of shallow wells may be more appropriate than toilet closure. The authors' opinion is informed through a study of the risk factors contributing to microbiological contamination of shallow wells in Kampala, Uganda.

The inference that the adoption of stipulated minimum distance of wells to sources of contamination may be a function of the level of (formal) education is also important.

The inference suggests that the better-informed would understand the drive behind the control measure and hence comply. The reverse is true for the less informed. The concern about the '*level of education*' can however be resolved by following the recommendation of the key informant in Box 10-2. The Public Health Officer claimed that '*we advise the people on the implication of the sources of pollution on the wells*'. In other words, public enlightenment through appropriate supporting programs is the key to achieve the adoption of a stipulated minimum distance of wells to established sources of water contamination.

I:	*What about the households with existing wells, toilet and grave sites within close distance of each other?*
KI_5:	*We advise the people on the implication of those sources of pollution on the wells. We do ask them to close up the wells because it is the wells that they can close.*

Source: Research interviews; I: Interviewer; KI: Key informant

Box 10-2: Required action when hand dug wells co-exists with sources of contaminations

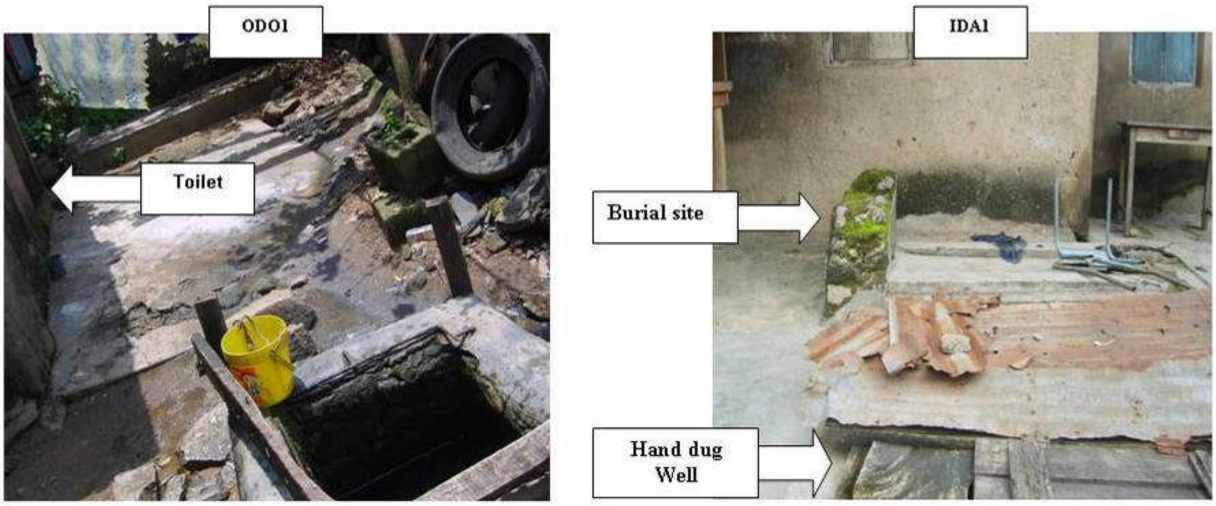


Figure 10-1: Co-existence of hand dug wells with toilet and burial site

The number of people in the Y category (6 out of 10) suggests that many water users would support the notion of a stipulated minimum distance of wells to sources of contamination. The support stemmed from the fact that '*nobody wants danger*' (R87). The comment of R87 suggests that diseases like cholera are perceived as dangerous as the respondents equally claimed that the control measure would '*prevent cholera*' (R91).

Two possible implementers are suggested for ensuring compliance with a minimum safe distance of wells to sources of contamination (Table 10-1). The named implementers are the government and the LLA. The government is named for three reasons. R91 believed that the government '*are in authority*'. R94 agreed because '*they* (the government) *have the resources to enforce*' the measure. R87 however wants the government to provide public burial sites, thus corroborating the need for the provision of public burial sites. The proposed government agencies are the Water Board, The Federal Ministry of Health or the PHD (Table 10-1).

10.1.5 Usage of dedicated bucket

In the absence of dedicated pumps, enforcement of the usage of a dedicated bucket for hand dug well operation represents an alternative control measure. The alternative control measure was debated by nine respondents. Five of the nine respondents agreed to the prospect. Two further respondents each are in the C and the N categories (Table 10-1).

The two respondents in the N category argued that '*people will not wait for their turn*' (R88), and '*the bucket can be spoilt*' (R90). Non-acceptability of the usage of dedicated bucket based on the argument that users 'will not wait their turn' is flawed. The argument is flawed because generally at public water points with single tap stands water users do 'wait their turn'. There should therefore be no justification for water users not to 'wait their turn' at hand dug wells if the measure would ensure safe water. Water users should hence be encouraged to 'wait their turn' at hand dug wells.

The notion that hand dug well operation bucket is a consumable that requires continual replacement is well reasoned but the solution is not difficult. R76 figured that ‘*We* (the resident users) *can be contributing the money for replacement or better rotate the replacement among ourselves*’! The figured out solution is however dependent on ‘*co-operation*’ among the resident users.

R95 in the C category entertained the reservation of ‘*if the resident users co-operate*’. The other respondent (R89) in the C category who believed that usage of dedicated bucket is functional only in ‘*strictly private residence*’ also implies the importance of some form of co-operation among resident users. Strictly private residence could mean a single household residence or residence with restricted access to non-resident users. Co-operation of resident users on hand dug well management cannot be overemphasised. Resident users have been identified as major players in hand dug well (source) management.

The five respondents in the Y category believed that disease (cholera) prevention is the main drive for the acceptance of usage of dedicated bucket. Otherwise R94 proposed to ‘*insist on pump*’ installation.

The three suggested actors for the role of implementing usage of dedicated bucket are; the government, the source owners or owner representatives, or the resident users (Table 10-1). The recommended government agency is the PHD.

10.1.6 Introduction of minimum age limit

Children are highlighted in this research as a controlled group in hand dug well management. And children activities around the well represent a critical control point. Introduction of minimum age limit for hand dug well operation is therefore a recommended critical control action. Of the 12 respondents that debated the critical control action, nine respondents are in favour while two respondents opposed the action. One respondent expressed a conditional support for the action (Table 10-1).

The respondent with the conditional support believed that enforcement of a minimum age limit would only be feasible in a '*strictly private residence*'. The concern that hand dug well management and control measures are feasible subject to restricted access is recurrent. The concern suggests that hand dug wells are better managed under restricted access than free access. It should however be noted that apart from ensuring safe water, control measures also serve to regulate (free) access.

The two respondents in opposition expressed the concern for the aged. R88 asked '*who should the aged send*'? And R96 echoed '*what happens to the aged*'?

The question of the respondents in the N category is answered in the reason provided by the respondents who supported the need for a minimum age limit in hand dug well operation. The Y category respondents believed that the critical action of stipulating a minimum age is needful to protect the lives of children. The activity of children as household water collectors is upheld but children would only be available to function as water collectors when they are unhurt or safe. The adults (in this instance, the aged) are also obliged to see to the safety of their children – the supposed household helpers.

The stipulation of a minimum age limit does not preclude children as water collectors. The control measure rather would serve to regulate or limit access to children old enough to act with certain degree of safety consciousness. The age limit proposed by the Y category respondents is a range from 6 years to 12 years (Table 10-2).

The number (nine out of 12) of respondents in the Y category suggests that stipulation of minimum age limit is generally acceptable to water users but the users vary on the critical action implementers. Three different actors are named (Table 10-1). They are the government, the LLA or the Heads of households. The suggested government agencies include the Federal Ministry of Health, the Water Board, and the PHD.

Table 10-2: Water user specified minimum age limit for hand dug well operation

Suggested minimum age limits (years)	Frequency
> 6	1
> 8	1
8 – 10	1
10	2
12	1

10.1.7 Source hygiene management measures and sanctions

Source hygiene rules and sanctions include control measures No. 7 and 8 in Table 10-1. Thirteen respondents commented on formalization of hygiene rules and sanctions. All thirteen respondents are unanimous in the acceptability of hygiene rules but one respondent believed that sanctions may be difficult to enforce (Table 10-1).

Two of the respondents claimed that hygiene rules are already being enforced '*we do all these*' (R87), '*…already in practice*' (R89). Another two respondents advised that awareness campaign may be necessary to achieve desired results with hygiene rules and sanctions. R91 however admonished '*…but do not include 'no talking'*'! The admonition of R91 suggests that inclusion of 'no talking' during well operation may be taking the essence of the hygiene rules too far. R62, a source owner claimed that he does not allow users to talk or chew stick[40] during water collection - implicitly to prevent saliva dropping into the well (Box 9-4).

The respondents are unanimous in their acceptability of hygiene rules and sanctions for three reasons. The reasons are '*the well areas will be neat*' (R81 and R90).

[40] Chewing stick is a local form of tooth brush. Chewing sticks are usually medicinal tree stems shaped and cut to sizeable lengths for intended usage. The sticks are kept in the mouth for as long as the chewer is able to soften the stick for effective tooth brushing. Since the stick softening takes a while, it is common practice for chewer to engage in household chores in a bid to redeem the chewing time.

'*Minimise certain diseases*' (R93). And '*improve water quality such that more people will have confidence to drink well water*' (R88).

The respondents however disagree on the control measure implementers. R86 particularly believed that '*the government should enlighten the people*'. R81 and R96 support the view of R86 but suggest that the enlightenment should be via the radio and television. R93 argued that the resident users and not the government are better suited to implement and enforce hygiene rules and sanctions.

Nonetheless, four likely implementers are proposed. The proposed actors are the government, the source owners, resident users, or Heads of households. The government agencies identified for the role include the Water Board and the PHD. The majority (6) however believed that source owners are best placed to implement hygiene rules and sanctions (Table 10-1).

10.1.8 Access and operation supervision

Access and operation supervision entails control measures nine, 10 and 11 in Table 10-1. The measures include formulation and display of access timetable, supervision of operation, or the locking of hand dug wells out of operation hours. The comments of the 14 respondents presented in this sub-section include views on standardised bucket recovery systems (control measure 12).

Formulation and display of access time table (control measure 9) relates to public (generally non-resident users) notification of when operation supervision would be available at any hand dug well. Control measure number 10 entails the enforcement of operation supervision. Of the 14 respondents, 10 are in support of control measures nine, 10 and 12. Three respondents expressed optimism in acceptability based on certain conditions while one of the respondents disapproved. Two of the 14 respondents however believed that locking of wells out of operation hours is not feasible (Table 10-1).

The respondents who disagree believed that access and operation measures would be difficult to uphold especially at peak operation hours and R88 added that '*users* (non-residents) *will break the locks*'! This research established that the majority of users prefer the morning hours of the day as water collection time (Table 9-3). The morning hours could thus imply the referred peak hours. Lock breaking is founded on the destructive tendencies attributed to especially the non-resident users.

The concerns expressed by the respondents who disagree is also re-echoed in one of the three conditions given by the C category respondents. R83 believed that except '*fine* (sanction) *is introduced*', access and operation measures would be impossible to enforce. One of the Y category respondents confirmed the sanction argument by declaring that '*we do seize buckets from children and release them (the buckets) to their parents*'. The clamour for sanctions re-affirms the importance and the need for exercising formal sanctions in the enforcement of hygiene rules, access and operation control measures.

'*Only for the educated*' (R92) is the second pre-condition for acceptability of access and operation measures. R92 believed that only the educated would be able to, for instance, formulate and display access time table. It should however be noted that control measures in source management are forms of water safety development activities. Another form of activity integrated in water safety plans is supporting programs. Supporting programs are activities targeted to create awareness, enlightenment, education and/or training to assist identified stakeholder groups (notably source owners) in water quality management and water safety development. It is therefore expected that educational status would not be a limiting factor to water safety development. All the same, appropriate training to assist the relevant actors in either access and operation control or standardisation of bucket recovery systems and tools is recommended.

The third stated pre-condition of '*if in private residence, yes*' (R90) is again recurrent. As earlier stated one of the importance of control measures is to regulate (free) access;

a feat that is presumed to be achieved only in private residences where access is restricted.

The Y category respondents are in the majority (at least 9 out of 14). The respondents opined that access and operation control measures are necessary to improve hand dug well water quality. Despite the majority agreement however, respondents differ in their suggestions for best actors.

Four actors are proposed for the possible implementation of access and operation measures (Table 10-1). The actors are the government, the source owners or owner representatives, resident users, or '*any sensible adult*' (R90). In the actor recommendations, the government is expected to initiate the '*policy*' and embark on enlightenment while the source owners are expected to '*communicate and enforce the measures*' (R95). The government agency identified for the role is the Water Board but most (6) respondents believed that source owners are better qualified for the role (Table 10-1).

10.1.9 Household water treatment and in-house storage hygiene

The establishment of household water treatment and in-house water storage hygiene comprise control measures 13 to 16 in Table 10-1. The total number of respondents who commented on household water related measures is 10. In terms of enforcement of household water treatment (control measure 13), four out of 10 respondents are in the Y category, and three respondents each in the N and C categories. For control measures 14 to 16 however, three respondents are in the Y category, four and three respondents are in categories N and C respectively (Table 10-1). In terms of the number of respondents in each category of response (i.e. Y, N and C), water users seem to be uniformly varied in views about household water related control measures.

The Y category respondents do not justify acceptability of the household water related control measures. However, the respondents in the C category postulated one pre-condition and foresaw a major hindrance. R87 embraced the establishment of control measures for household water subject to if the measures are backed up '*with enlightenment*'. R94 toed the same line of thought by stating '*if there is awareness*'. R88 however believed that the measures are good '*but can not be monitored*'. The N category respondents disagree on similar principles with the C category interviewees. R93 argued that control measures for household water are not '*issues for enforcement* but *issues for enlightenment*'. And R90 claimed that '*poverty can not make this work but enlightenment is crucial*'.

The stated views raise two main important issues:

- Enforcement versus enlightenment, and
- The problem of poverty

The two highlighted issues are well articulated by R90. The respondent explained '*if people are enlightened or if you can educate the people, the measures can work. Otherwise you can not enforce the measures. How do you want to monitor if people do any of these or not but constant education will change people gradually*'. The same respondent continued '*poverty won't make these work in Nigeria. The one that can not afford food can not be asked to treat the water*'. The surmise on the impact of poverty made by R90 is confirmed by International Monetary Fund (2005). In which the claim is made that seven out of every 10 Nigerians live on less than $1 a day.

The argument put forward by R90 implies that important as household water treatment and related in-house hygiene control measures may seem, the adoption of the measures can not be enforced. Rather water users can only be encouraged to adopt the practices through appropriate awareness campaigns and enlightenment initiatives. The argument also implies that the expected adoption would be a function of time.

Understanding the attitude of water users to household water treatment in particular would however be critical to the development of appropriate adoption campaign. Apart from being encouraged to adopt household water treatment and hygiene practices, there would be the prerequisite for water users to recognize the need for the uptake of such measures. The need for water users to comprehend the importance of water treatment and household hygiene practices is demonstrated in the argument made by R95.

R95 has access to tap water source. In his reason for un-acceptability of household water treatment declared that '*who wants to enforce such measures? I will rather pour the water away than treat or use alum*'. The phrase '*I will rather pour the water away*' may depict a tenable reaction where there are alternative water sources that are both accessible and safe for consumption. In the absence of accessible and safe alternative water sources however, as is the case in the study area, household water treatments remain a plausible option to ensuring consumption of safe water.

Encouragement informed through comprehension of the need for the adoption of household water treatment and in-house hygiene practices through appropriate enlightenment campaigns thus becomes crucial. It should be recalled that the drinking water sources in the study area are generally not safe for consumption (Tables 7-1 and 7-2).

Four categories of actors are recommended for the implementation of household water related control measures. The first category is the government. The government is proposed because as noted by R81 '*the government has the monetary resources to support the policy*'. And R94 suggested the Ministry of Health as the relevant government agency. Three respondents proposed the Heads of households as best candidates for the implementation of household water related control measures. One respondent recommends '*any adult*' but R86 believed that the best candidate for implementation of the named measures should be the '*whosoever that does not want to spend money on ailments*'!

10.1.10 Regulatory measures

Formulation of regulatory measures is included in control measures 17 to 19 in Table 10-1. The regulatory measures include hand dug well water quality monitoring, inspection of well handling and source hygiene practices, and formal regulation of source management practices. Eleven respondents debated the referred regulatory measures. Seven respondents are in the C category, three in the N category, and only one respondent is in the Y category (Table 10-1).

The Y category respondent believed that adoption of regulatory measures would bring about the provision of clean well water. The seven C category respondents however argued that acceptability of regulatory measures depends on whether the regulatory measures are '*well stated and passed across*' (R81). '*The government can do it* (i.e. formulate the measures)' (R83, R90, & R95). The measures become a (government) '*policy*' (R89). Enforcement '*does not involve payment by water users*' (R86), and if there is '*adequate enlightenment*' (R93).

The respondents from the above suppositions made four important observations. The respondents recognize:

- The role of the government in policy or regulation formulation
- The need for adequate dissemination of regulatory measures
- The importance of enlightenment, and
- The need for incentives

The highlighted observations thus signify the four major factors that may influence the acceptance of regulatory measures by the water users.

The role of the government in policy or regulation formulation is critical to acceptability or adoption of control measures. Six of the 11 respondents believed that source management regulation and formulation of any regulatory measure should be the responsibility of the government. R89 expected that government water regulatory measures should be disseminated by source owners to resident users. R93 assigned the role of enlightenment to non-governmental organizations (NGO) and to educational institutions like the universities.

One of the N category respondents however particularly disapproved of regulatory measures because of the financial implications. The woman queried '*would the government give us* (the source owners) *money to do this* (monitor water quality and inspect source handling)' (R96)? The respondent's query suggests the expectation of possible incentives with the implementation of regulatory measures.

The idea of incentives suggested by R96 signifies that incentives may play a key role in acceptability or adoption of regulatory measures. Incentives may be provided in two ways. In the first instance incentive may be provided in the form of subsidies as suggested by R96. Subsidies could be provided to source owners to for example improve or upgrade source construction quality and design to the recommended standard.

The second means of creating incentive may be in the form of providing facilities that would enhance the adoption of regulatory measures. An example is laboratory facilities, which could be provided for source water quality monitoring. And such facilities should be made affordable and easily accessible to water users.

With appropriate incentives in place, certified source construction documents or certificate for instance issued by the relevant authority could be provided on demand to surveillance or regulatory operatives. Appropriate incentives could thus facilitate the adoption and implementation of regulatory measures. The issue of who should create the incentives will however be discussed in chapter 11.

10.1.11 Supporting programs

Making supporting programs compulsory for source owners and managers (for example), for the purpose of water safety development is recommended in the twentieth control measure (Table 10-1). Supporting programs are activities that ensure the operating environment, materials and equipment used, and the people themselves do not become additional source of potential hazards to the water source (Davison et. al., 2005). Enlightenment, education and trainings, or re-training (as the case may be) are activities lined up within supporting programs. Supporting programs as a control measure is in the context of this discussion seen as an attempt to make the intended recipients participate in such programs.

Twelve respondents debated the possibility of enforcing compulsory support programs on water users. Six of the respondents supported the idea (Y category), four respondents agreed based on stated conditions (C category) while two respondents objected to the notion (N category).

The respondents in the N category objected based on the previously discussed notion of incentives '*are they going to give us money there* (R95 & R96)?' However beside the hints for incentives, the respondents' query also recalls an important point. The point is recognition of the need to participate in supporting programs. Supporting programs should emphasise the benefits that the participants stand to gain besides subsidies or incentives. Quantifying for instance the expected health gains in ensuring the source and water safety. Appropriate supporting programs should therefore entail two major components; the prerequisites and the actual training courses. The prerequisites should address the need for the adoption of stipulated control measures and the relevance of participation in regulatory supporting programs.

The pre-conditions expressed by the C category respondents are the expectations of the involvement of the government in the design of the support programs, and proper dissemination of the designed programs to the intended recipients.

The Y category respondents are clear about who the participants should be. The respondents believed that involving all water users in education and trainings would not be effective. According to R88 for instance, '*local chiefs, source owners, or source owner representatives*' should be the target of any educational and training programs. R95 added '*delegated resident users*' to the list. R93 advised that '*trainings would be effective through seminars*'. R90 suggests that public awareness campaigns or enlightenment should be routed '*through the media*' while R95 specified the radio and television as the relevant suitable media outlets. R95 further suggests that enlightenment campaign programs should be conducted in '*many languages*'. The advice of '*many languages*' is appropriate because Nigeria is generally a multi-lingual country.

The number (6 out of 12) of respondents in the Y category suggests that water users are keen on being involved in likely support program initiatives (Table 10-1). The Y category respondents suggest media involvement in enlightenment campaigns.

To verify the keenness of water users on water safety awareness campaigns, 15 respondents were asked to comment on some follow-on questions in a separate interview sessions on: if they had or would like to receive information on water safety issues, who should provide such information, and what their preferred medium of information is.

The ardour of water users to water safety awareness campaigns is shown in Table 10-3. Although 12 of the 15 respondents claimed that they did not receive any water safety related information prior to the conducted interview session, 12 (or 80%) of the interviewees would like to receive the information. The minority (3 out of 15) claimed to have received water related information sometimes. And another three respondents claimed that they are not interested in water safety information (Table 10-3).

Table 10-3: Keenness of water users to water safety awareness campaigns

Enquiries	Responses	Frequency
Received water related information prior to interview session	Yes	3
	No	12
Would like to receive water safety related information	Yes	12
	No	3
Who should provide water safety related information?	Government	
	▪ The WB	3
	▪ PHD	3
	▪ MOH	1
	▪ MWR	1
	▪ NS	2
	Educational institutions	1
	Clubs or associations	1
	Individual water users	1

N = 15; WB: Water Board; PHD: Public health department; MOH: Ministry of Health; MWR: Ministry of Water Resources; NS: Not specified

The three respondents who are not interested in receiving information on water safety gave varied reasons. R83 explained that '*I do not have the time; I concentrate on my trade*'. R89 reasoned that '*I have my well already; the information would be useful to those who are yet to get their own water source*'. The third respondent believed that '*we do not need such information because we all know that drinking dirty water will harm us*' (R96).

The excuse of time given by R83 may explain why involving all water users in education and trainings may be ineffective. The ineffectiveness of involving all water users in trainings is earlier mentioned by R95. The excuse of time will not however be relevant to enlightenment initiatives conducted through public information media. R83 equally claimed to '*have my radio by my side 24 hours a day*' suggesting that awareness campaign routed through her favourite medium of information would neutralise the '*I have no time*' factor.

Selective usefulness of water safety information is suggested in the remark made by R89. It should however be noted that water safety information is expected, if appropriated, to ensure the safety of water sources irrespective of whether the sources are old or new.

R96 implies that water users are clear about the danger inherent in the consumption of unsafe water. However it is apparent from the hygiene practices and hand dug well water handling reported in this research that water users are not so clear on what to do to ensure the source and water safety. As such the 'I know all' attitude suggested by R96 should be discouraged as it represents a danger to the development of source, water, and health safety.

The respondents who are eager to receive water related information believed that water safety information is a right for water users. The other stated reasons are '*for health and safety*' (R87), because of '*diseases like typhoid*' (R90), and '*people will learn how to make the changes to care for water*' (R94). Knowledge of hygiene and water safety consciousness is added by R95 (Box 10-3).

Ten of the 12 respondents who were willing to receive water safety information claimed in the words of R81 and R82 that '*the government should provide the citizens with information… about the safety of using clean water*'. R82 further added '*…especially the source owners, so that the source owners could pass such information to the resident users*'. The proposed government agencies are presented in Table 10-3. Apart from the government, the respondents suggested three other possible actors; the educational institutions, social clubs or associations, and '*individual water users*' (R94). R94 particularly believed that individual water users should be encouraged to cultivate the act of seeking safety related information. It is however rather obvious that sort of information can be found only if available! There is therefore the need to make water safety information available.

I:	*Do you get information about water related issues/topics?*
R_{95}:	*No*
I:	*Do you think you should get such information?*
R_{95}:	*Yes*
I:	*Why?*
R_{95}:	*It will help one to know hygiene and to be conscious of the dangers of impure water and how to take care of it.*
I:	*So you are aware that there are dangers in water?*
R_{95}:	*Yes, there are dangers in water and I'm very conscious of it that is why I don't drink well water; sometimes, some greenish particles are seen from it and sometimes larvae are found in it.*
I:	*Who should provide such information?*
R_{95}:	*We have the Ministry of Water Resources and the Public Health Workers. PHW inspect. It is their duty to monitor how clean we are. If they see anything that is not good, they should be able to educate us. But for the past 7 years that I have been in this house, I have not seen any health worker come around but I know they visit restaurants and eating joints here in Abeokuta.*
I:	*What or how is the best way for you to get information?*
R_{95}:	*Television.*
I:	*Why do you prefer television?*
R_{95}:	*I prefer television because it gives pictorial view of what is going on. For instance when flooding took place in Abeokuta in 2007, the television showed it better.*
I:	*What time of the day do you enjoy watching television?*
R_{95}:	*Evening. That is the time that I'm free especially between 8p.m to 10p.m*

Source: Research interviews; I: Interviewer; R: Respondent

Box 10-3: Dialogue on the importance of water safety information

The preferred media of information stated by the respondents are highlighted in Figure 10-2. Five different information outlets are mentioned; the print media, online medium, radio, television (as the electronic media), and inter-personal means of communication. The inter-personal means relates to information sharing between neighbours, friends and relatives. The most preferred medium is however the television.

The most preferred medium of information may not however signify the most effective means of information dissemination. Judging by media accessibility shown in Table 10-4, the respondents who preferred the radio generally claimed ability to access the medium at anytime of the day. Access is either through the portable radio or mobile telephones. Access to television is usually in the evening between 7pm and 10pm (Table 10-4). Access to television is also subject to availability of power supply. Power supply is generally erratic. Two respondents also claim to read the newspapers and magazines in the morning. From Table 10-4 therefore, radio fans have the most interactive time (24 hours) with their preferred medium, suggesting that radio users are not likely to miss out on information routed via the medium.

Apart from the highlighted means of communication, the outdoor media comprising of posters and bill boards are also recommended for water safety campaigns especially for the water users who are out and about.

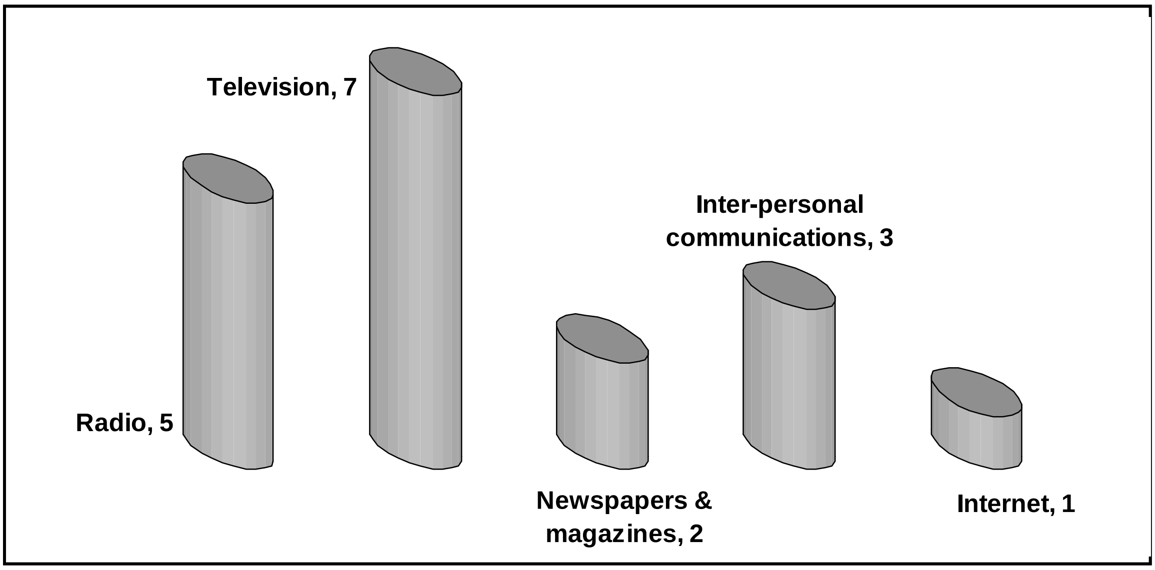


Figure 10-2: Preferences of information medium for water users

Table 10-4: Time of engagement with preferred information media

Media options	Time of engagement	No. of respondents
Television	Anytime there is power supply	1
	Evenings	1
	From 7pm	1
	From 9pm	2
	8pm – 10pm	2
Radio	From 9.30am	1
	24 hours a day	4
Print media	Mornings	2
Telephone internet browsing	Anytime	1

10.2 Control Measures in Water Safety Plans

The degree of acceptability of each of the presented 20 control measures is highlighted in Table 10-5. The degree of acceptance is important to summarise the implication of the enumerated control measures to water safety plans.

In Table 10-5 strong acceptance or rejection level is assigned to control measures with more than 70% respondent in favour of acceptance or rejection. Acceptance or rejection based on simple majority is assigned to control measures with 50 – 70% respondent acceptance or rejection. Strong acceptance if specified conditions are met is allocated to control measures, which achieved more than 70% respondent acceptance when the percentage of respondents in the Y and C categories are summed up. Consequently, five control measure groupings are derived from Table 10-5.

The identified five control measure groupings with the number of control measures in each group is presented in Table 10-6. Table 10-6 thus highlights the control measures that are generally acceptable to hand dug well users. The control measures highlighted as generally acceptable are recommended for inclusion in water safety plans for hand dug wells. The rejected measures however may not be included in the plans.

Table 10-5: Degree of acceptability of identified control measures

Control measures (Serial Nos.)	Rejection (%)	Acceptance (%)	Acceptance (Conditional) (%)
1 [b]	57	0	43
2 [e]	93	7	0
3[a]	8	77	15
4 [c]	10	60	30
5 [c]	22	56	22
6 [a]	17	75	8
7 [a]	0	100	0
8 [a]	8	92	0
9 [a]	7	71	22
10 [a]	7	71	22
11 [c]	14	64	22
12 [a]	7	71	22
13 [c]	30	40	30
14 [d]	40	30	30
15 [d]	40	30	30
16 [d]	40	30	30
17 [c]	9	27	64
18 [c]	9	27	64
19 [c]	9	27	64
20 [c]	9	55	36

a: Strong acceptance (> 70 %); b: Strong rejection (> 70%); c: Strong acceptance if conditions are met (>70%); d: Acceptance based on simple majority (50 – 70%); e: Rejection based on simple majority (50 – 70 %)

Table 10-6: General acceptance level of control measures, N = 20

Control measure groups	Number of measures
Strong acceptance [a]	7
Strong rejection [b]	1
Acceptance based on simple majority [a]	3
Rejection based on simple majority [b]	1
Strong acceptance if specified conditions are met [a]	8

a: General acceptance; b: General rejection

In summary therefore, the control measures (serial number in parenthesis) that are strongly acceptable to water users include:

- Cleaning of well area (3)
- Minimum age limit (6)
- Source hygiene management rules (7)

- Sanction of un-ruly behaviour (8)
- Display and compliance with access time (9)
- Access time supervision (7)
- Standard bucket recovery system (12)

The control measures, which possess strong acceptability if various specified conditions are met include:

- Minimum distance to source of waste (4)
- Usage of dedicated bucket (5)
- Lock well when out of use (11)
- Household water treatment policy (13)
- Monitoring of water quality status (17)
- Inspection of well handling & hygiene (18)
- Regulation of source management (19)
- Compulsory supporting programs (20)

The various major requirements for general acceptability of control measures include:

- Provision of public burial grounds, which are easily accessible (minimum bureaucratic procedure of procurement) for both private and public usage.
- Public enlightenment focused on the need and expected benefits from stipulated control measures.
- Co-operation especially among the resident users – the source managers.
- Establishment of sanctions for non-compliance
- Appropriate training of relevant actors in the following areas:
    - Access control
    - Operation management
    - Hygiene management
    - Bucket recovery tools and system development
- Provision of incentives in especially the following areas:
    - Subsidies to enhance public acceptance of approved well construction design with usage of recommended construction material

  - Provision of water safety facilities like laboratories for water quality monitoring and surveillance
  - Provision of household water treatment solutions and subsidies to encourage the adoption
- Government involvement in the design and implementation of supporting programs and dissemination of water safety information to users.

The control measures with acceptability based on simple majority are:

- Hand washing before storage usage (14)
- Usage of in-house storage cover (15)
- Usage of in-house storage bailer (16)

The above measures are particularly regarded as measures for enlightenment rather than control.

The control measure that is generally not acceptable to water users is the imposition of dedicated pump. Water users would not accede to the control measure and as such should not be included as water safety measure for hand dug wells. Introduction of standardised well construction design including specifications for the quality of construction materials is rejected based on simple majority (57%; Table 10-5). A shift to general acceptance (from current 43% to more than or equal to 50%) may however be achieved with the provision of subsidies to encourage acceptance, and if a range of design and construction materials are stipulated. A range from best practice to safer practice is recommended (10.1.1).

Aside acceptability of control measures, water users assigned preferred actors for implementation of the highlighted control measures. The identified actors in institutional framework for hand dug well management are presented in the next chapter.

11 INSTITUTIONAL ASPECTS: FRAMEWORK FOR WATER PROVISION AND MANAGEMENT IN ABEOKUTA, NIGERIA

As discussed in earlier chapters of this thesis various knowledge levels are exhibited by water users in regards to source water safety (Chapter 6). Prominent among the knowledge levels is the expressed lack of knowledge of source water safety (Box 6-13). The expressed knowledge level infers that many owners or operators of hand dug well (self supply) sources lack the technical expertise or competence to develop and ensure the water safety management of their sources. Many of these individual source owners also lack the skill to initiate the actions needed in water safety plans. Recognition of lack of technical expertise of source owners suggests the need for an appropriate established institution to oversee and spearhead the development of water safety guidance for self supply sources.

Notable actors or stakeholders are identified in the evaluation of control measures in chapter 10. The identified actors feature in hand dug well management in particular but also in water supply management in Abeokuta as a whole. The specified actors cut across a wide range of organizations, groups and individuals, from government to non governmental organizations, educational institutions, and social group associations to individuals, such as the source owners (Figure11-1). The specified government groups also span the three major tiers of government in Nigeria; the federal, state and the local government councils.

Figure 11-1 presents the existing involvement of the various identified actors in water supply management in the study area. The existing involvement is also corroborated by key informants in some of the identified institutions. This chapter presents and discusses the existing roles of the specified actors in order to identify the appropriate institution for hand dug well (invariably self supply systems) water safety management. The identified institution is expected to facilitate the development of self supply water safety plans in conjunction with other relevant key actors.

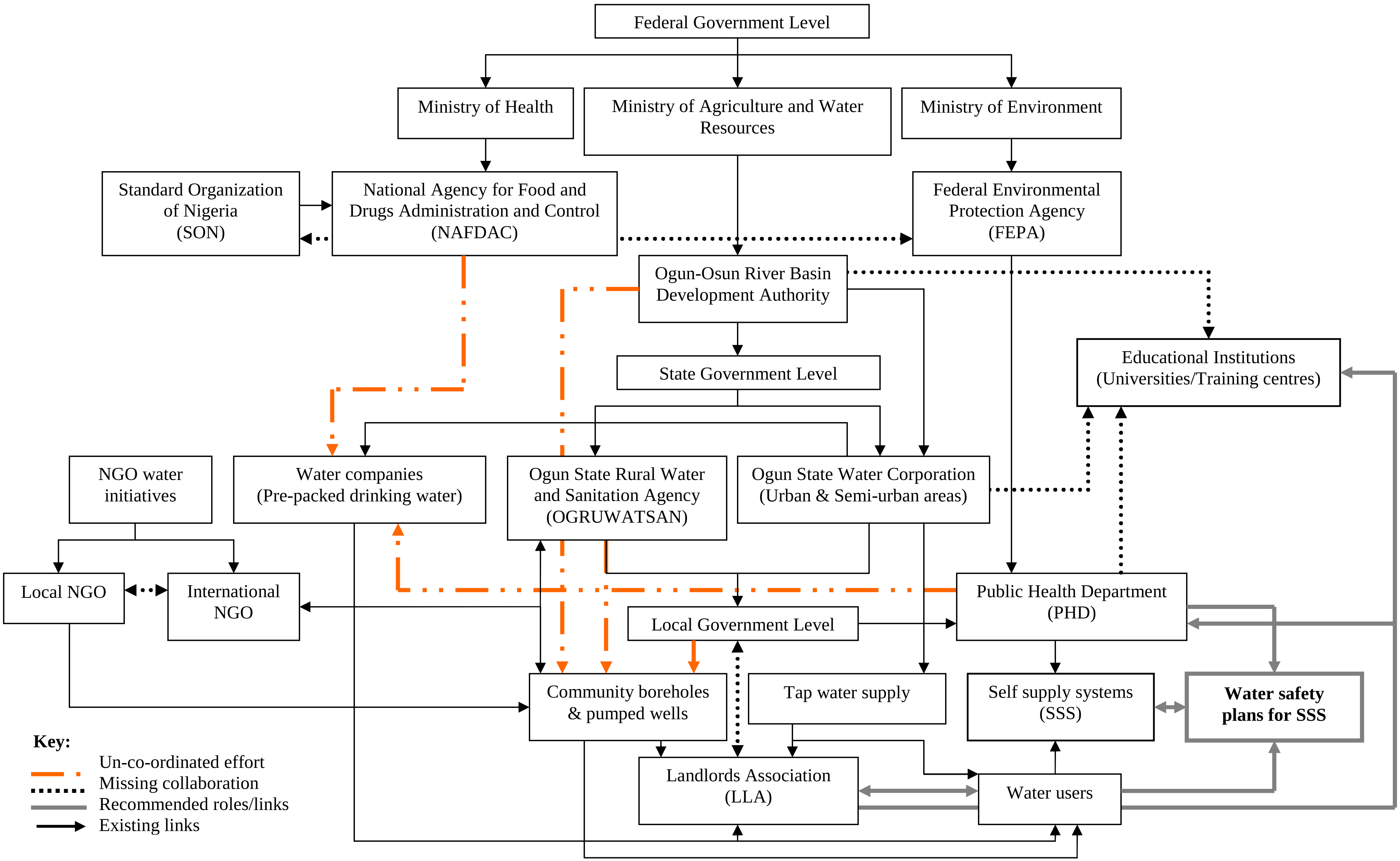


Figure 11-1: Drinking-water provision and management in Abeokuta, Nigeria

11.1 Water Supply Management Framework

The water supply management framework is discussed in three levels. The levels signify the existing three major tiers of government in the country namely the federal, state and the local government councils.

11.1.1 Federal Government level

Three ministries were identified as relevant to water supply and management at the federal government level (Figure 11-1). The ministries are the Ministry of Agriculture and Water Resources, the Ministry of Health (MOH) and the Ministry of Environment (MOE). Of the three ministries, the Ministry of Agriculture and Water Resources has the most direct relevance to water supply management. The vehicle of the nation's integrated water resources management under the Ministry of Agriculture and Water Resources is however the River Basin Development Authority, RBDA (Akanmu et al., 2007).

The RBDAs were established in 1976 to plan, facilitate and create the enabling environment for integrated conservation, development and management of various water uses for the preservation of the quality and quantity of the fresh water ecosystems. Twelve RBDAs was set up across the country, but the relevant RBDA to Abeokuta, the research area is the Ogun-Osun river basin development authority (Box 11-1).

Ogun-Osun RBDA is responsible for the management of the catchment areas captured around two rivers - Ogun and Osun River. Ogun River, the larger of the two rivers, spans three states of Oyo, Ogun and Lagos States of Nigeria. Osun River and its tributaries empty into Ogun River. By virtue of its role, Ogun-Osun RBDA allocates fresh water supply to the Ogun State Water Corporation for treatment and distribution to cities and towns within the twenty local government areas of the State.

In 1975 when the defunct Federal Ministry of Water Resources was initially created, the responsibility of nationwide river management administration had not been attached to the said Ministry. And the Federal Inland Water Department for inland navigation is still responsible for the management of the Niger and the Benue. Prior to August 1993 when the water Resources Decree 101 was promulgated, there was virtually no single agency that was responsible for an integrated river management on use and conservation of the water resources and river systems. Currently, in Nigeria we have the following river basin development authorities (RBDA).

1. *Anambra-Imo River Basin Development Authority*
2. *Benin Owena River Basin Development Authority*
3. *Chad River Basin Development Authority*
4. *Cross River Basin Development Authority*
5. *Hadejia-Jama'are River Basin Development Authority*
6. *Lower Benue River Basin Development Authority*
7. *Lower Niger River Basin Development Authority*
8. *Niger Delta Basin Authority*
9. *Ogun-Osun River Basin Development Authority*
10. *Upper Benue River Basin Development Authority*
11. *Upper Niger River Basin Development Authority*
12. *Sokoto-Rima River Basin Development Authority*

Source: Akanmu et al. (2007)

Box 11-1: Excerpt on the history of the river basin development authorities in Nigeria

The roles of both the Ministry of Health and Ministry of Environment have no direct implication or involvement with water supply management. There is however an indirect link through the regulatory activities of NAFDAC and FEPA (Figure 11-1).

The National Agency for Food and Drug Administration and Control, NAFDAC is an agency of the Federal Ministry of Health in Nigeria. The agency is established by (an amended) Decree No. 15 of 1993 (NAFDAC, 2009). The mandate of the agency is to regulate and control quality standards for foods, drugs, cosmetics, medical devices, chemicals, detergents and packaged water imported, manufactured locally and distributed in Nigeria. The mission of the agency is '*to safeguard public health by ensuring that only the right quality products are manufactured, imported, exported, advertised, distributed, sold and used*'. And the overall vision is '*to safeguard public health*' (NAFDAC, 2009).

From the mandate and overall vision of NAFDAC, the indirect involvement of the MOH through NAFDAC to water supply management is in two ways:

- Regulation of pre-packed drinking water products. Examples of pre-packed drinking water products include sachet (popularly referred as 'pure') water, bottled water for retail and bulk purchases and/or for individual and corporate uses. It is however common to find vendors of pre-packed drinking water products, which do not conform with stipulated standards.
- Safeguard public health

Regulation of pre-packed drinking water products suggests that NAFDAC activities in water supply management are restricted to commercial drinking water providers to safeguard public health. The overriding aim in water supply or quality management is also to ensure public health.

The Standards Organization of Nigeria, SON however formulates or draws up the standards for the various regulatory products including drinking water products and sources. A key informant, KI5 in the organization explains '*SON drafts standards. It is the duty of relevant agencies to ensure compliance with the set standards. In the case of water, NAFDAC and NIS* (Nigeria Industrial Standards) *are supposed to ensure compliance. Any water company must have both NAFDAC and NIS registration before they can operate. SON is also involved in ensuring the quality of any construction*'.

The Federal Environmental Protection Agency, FEPA is an agency of the Federal Ministry of Environment. The indirect role of FEPA in water supply and management is routed through the activities of the Public Health Department, PHD. The PHD is administratively placed under FEPA in the MOE because as stated by one of the key informants, KI4 '*we are Environmental Health Officers*'. PHD is however seconded to the local government areas to be the arm of FEPA at the grass root level of governance. The activities of PHD and their role in water management are discussed in a later sub-section.

11.1.2 The State Government level

At the state government level, the Ogun State Water Corporation in the words of KI3 '*produce and supply potable water to the entire citizens of Ogun State*'. KI3 however further explained that '*we are not into the rural areas. We have another agency OGRUWA; they are in charge of small areas that we can not cover. We are in the urban and semi-urban areas like Abeokuta, Ijebu-Ode, and all the bigger towns*'. The Water Corporation is thus solely responsible for the tap or public water supply in Abeokuta.

The statement of KI3 also referred to another water agency at the State level – the Ogun State Rural Water and Sanitation Agency, OGRUWATSAN. According to the Head of water supply in the agency, '*It is a State government agency in collaboration with UNICEF to provide water for people particularly those in the rural areas. Ogun State is one of the guinea worm endemic states in Nigeria and there are two local governments that are actually involved. That was why the UNICEF collaborated with the state government to provide water for the rural people in the endemic places*' (KI2).

KI2 in the above statement specified the role of an international agency, UNICEF, in water provision at the state level. NGO involvement in water supply is also corroborated by another key informant, KI1. KI1 explained that '*There are NGOs like private clubs – Rotary International, Lions clubs and the likes that dig wells for people and less frequently boreholes and apart from that you have international organizations like the UNICEF. UNICEF has been doing a lot, with respect to sinking of boreholes and also UNDP, but UNICEF is perhaps the most active of all the international organizations that are looking into water problems and water provision and supply in Abeokuta and environs*'.

The statements of KI1 and KI2 reveal direct involvement of NGO and especially INGO through collaborative effort or partnership in water supply management. The statement of KI2 also infers that the ultimate aim of the INGO collaboration in water supply is public health – eradication of guinea worm.

Two differences are visible in the operations of the two water agencies at the state level i.e. the Water Corporation and the OGRUWATSAN. The differences are in the area (or coverage) of operation and the source of water supply. The water supply operation of the Water Corporation is for the urban and the semi-urban. The main source of water is surface water supply (Ogun River). OGRUWATSAN is however focused on the development of ground water supply for the rural areas. KI2 clarified that when OGRUWATSAN was established '*the proposal was for each Ward to have 5 boreholes…We have about 235 wards in the state and if you multiply the figure by five it will be over one thousand*'.

The water supply activities of the Water Corporation is however not limited to provision of potable water for household consumption. In Abeokuta, the regulated commercial water providers that are in the business of pre-packaged water purchase some form of 'water rights' from the Water Corporation. It is a form of 'water rights' because KI1 claimed that the 'water right' is actually a tapping or exploitative activity '*…now in Abeokuta, many commercial water providers acquire properties close to the Water Corporation Headquarters. You must have noticed the many chalets along and very close to the Water Corporation. The commercial water providers now tap water directly from the mains of the Water Corporation. The Water Corporation knows about this. They have a fixed amount they charge and collect from the water providers monthly for these tapping activities*'.

From the foregoing therefore, four main water supply actors are identified at the state level of governance. The actors are the Water Corporation, OGRUWATSAN, the NGO and the commercial water providers. The named actors are directly involved in water supply through the public tap, ground water development via boreholes and deep wells, and pre-packed drinking water products respectively.

11.1.3 The Local Government level

The water supply activity of the local government areas is indicated in the comments of KI1 and KI3. KI1 declared that '…*since 1979* (commencement of democratic rule in Nigeria), *provision of water has been featuring prominently in the programs of State, Federal and local government'*. And KI3 corroborates that '*The local government, state government and federal government are all into water supply*'. The response of KI3 to a follow-on question however reveals that '*We don't have the records of either borehole provided by the state government or the local government…*' The response suggests that the water supply operations of the local government councils are actualised through the provision of deep wells or boreholes to communities within their jurisdiction.

A major problem is however identified by KI1 regarding the involvement of the local government council in the management of water supply. KI1 observes '*this is the government agency that is nearest to the people but that is given the least responsibility...*' He exemplified his observation through the review of the SON document on the water quality guidelines for Nigeria. He explained '*looking at the document stakeholder list, I cannot see the involvement of the Local Government Council. Meanwhile, the LGC are the closest to the people but of course not mentioned in this document*'. The respondent re-emphasised the role of the local government to the grass root by further stating that '*The state government and the Ministries have a lot on their hands for them to start dealing with the grass root problems*'. He however supposed '*Well, may be because the expertise is lacking at this level of government*'.

The observation made by KI1 implies non-involvement of LG representatives in the formulation of the water quality guidelines for the nation due to lack of expertise at that level of governance. The same respondent however opined that lack of expertise can be corrected through training (Box 11-2).

KI1 in Box 11-2 proposed two main approaches to training:

- Movement of experts from the State government to the local government
- Training through educational institutions

The first approach connotes an understudy style of training while the second approach implies some form of formal education. In terms of capacity building through the formal approach, Box 11-2 made further suggestions:

- Training institutes should be located close to the intended; otherwise training should be taken to the recipients.
- Incorporation of three categories of training programs; short, medium or long term
- Involvement of higher education institutes in capacity building programs.

In Box 11-2, KI1 mentioned the existence of one water training institute and at least one higher educational institution (university) currently involved in formal training programs in water management. They are The Institute of Water Resources, Kaduna, and The University of Agriculture, Abeokuta. The former is located in Northern Nigeria. The named University is however located within the suburbs of Abeokuta. The number of existing institutions currently running formal courses in water management is however grossly limited. That is considering the number of local government areas in especially Ogun State (Twenty LGA), the seat of the study area or in Nigeria as a whole. Two possible options may be considered. The establishment of more water management minded training institutions or the inclusion of water management programs in institutions that are currently not offering the referred programs. Either way the options would require to varying degrees one or more of training facilities, personnel and running costs. Thus considering the possible cost implications both options would be long term projects.

Taking formal training programs to the intended may be less capital intensive but the method of achieving the recommendation is not clarified. The proposal of short, medium or long term formal training programs may however be a more probable formal training approach. As explained in Box 11-2, a 3 to 6 months formal training programs may serve in the short term the purpose of urgent or initial basic capacity building. Subsequently subject to available human and financial resources (for instance), formal capacity building plans may be integrated in the local government water development programs. The integrated plans may then target specialist programs for a medium to long term training.

The proposed involvement of higher education institutes is plausible but the academic curriculum of many universities especially the Water Management Department in the referred University do not allow for short term formal training programs. Currently, formal water management trainings revolve round the traditional undergraduate and postgraduate programs. KI1 in Box 11-2 however believed that '*Senate* (the highest academic award body within the university establishment) *approval could be sort for such short courses*'. The respondent equally expected that formal certification for intended courses could be granted through the relevant academic award body to validate the formal training programs.

The various recommendations of KI1 thus suggest an indirect role of the education institutions in water management.

Another important highlight in Box 11-2 is the emphasis on the role of the local government to the '*grass roots*' – in the context of the discussion the water end users. In terms of hierarchy the local government is '*closest*' to water users and by implication should be more responsible for water supply and quality management. Also by virtue of the '*grass root*' role, the local government should involve '*…the landlords associations*'. Thus Box 11-2 introduces the involvement of yet another key player in water management – the Landlord Associations, LLA.

Landlords are property owners; invariably the hand dug well (source) owners. KI1 suggests the involvement of the LLA especially as water safety managers or co-ordinators of water safety plans for self supply sources (Box 11-3). As source owners and consequently the beneficiary of any water supply or quality management, KI1 surmised that the LLA '*…are in the best position*' for the role. The respondent implied sustainability in the role suggestion. The LLA involvement in especially water safety management would be sustainable because the LLA are already in existence. Sustainability is also due to the recognised organised nature of the LLA (Box 11-3).

> *Generally, I believe that the issue of infrastructure development should be the responsibility of the Local Government. The only problem that the local government may have is lack of expertise. But that could be built up. Experts could be moved from the States to the local government to monitor certain things. LG are the grass root operators. Many of the problems we are talking about are not relevant to the government reserved areas (GRA). The problems are with the masses; rural and urban. The LG too do not know what they are supposed to do. They have the money (the resources) but do not know what to spend on.*
>
> *But my own idea is that the LG officials should be involved even though they are handicapped and that could be solved through training. You can train them and get them involved. You can have long term, medium and short term training; even of 3 – 6 months training. Train them within 3 – 6 months and they will be able to function in that role and effective.*
>
> *The training institutions; the existing institutions could do the training. For instance The Institute of Water Resources in Kaduna offer short trainings but cater for only the people in the northern part of the country. The kind of training we need should be located close to the people otherwise training should be carried to the people.*
>
> *Who will provide certification for such trainings?*
>
> *University (Institutions) Senate permission could be sought for such short courses*
>
> *The state government and the Ministries have a lot on their hands for them to start dealing with the grass root problems. Then off course the Landlords Association should be involved.*

Source: Research key informant interviews

Box 11-2: A key informant views on the role of the local government in water development

Box 11-3 again suggests the mode of LLA participation. LLA are expected by KI1 to be involved in water management through induced awareness campaign. The respondent believed the awareness should be induced by the government but the appropriate government organ for the job is the local government councils '*the local government council should get them (the LLA) on-board*'. An important insinuation was however made by KI1 '*involving the LLA may mean admitting to failure in water provision*' (Box 11-3). The insinuation of government admission of failure in water provision is discussed further in the next section. It should however be noted that the role of the LLA in especially water safety management is proposed.

KI_1:	*The Landlords Association at inception have a single term of reference – security of life and property. But in tackling that, they have become so organised now that one can pin more responsibility on them, since they are the ultimate stakeholders. Maybe their role could be extended through awareness. Making them to know that they are in the best position to do it (co-ordinate water safety activities for self supply sources) and I'm sure they would do it.*
I:	*But who should create that awareness?*
KI_1:	*Who created the awareness for safety of life and property? It just came. It was spontaneous because they realised the problem was there and people were losing lives and properties. So it was automatic. But in this case, the awareness could be induced. The LG is the nearest to them. The State government and no government official will not be able to or be ready to involve the Landlords directly. Involving the landlords may mean admitting to failure in water provision. But the LG should be able to get them on-board*

Source: Research key informant interviews; I: Interviewer; KI: Key informant

Box 11-3: Proposed role of the Land Lords Association in water management

11.2 Failure of the State in Water Supply Management

Water provision is one of the social responsibilities of any government to the citizenry. One of the key informants, KI1 in his response to water supply management in Abeokuta shares the sentiment that '*It has always been the responsibility of government to supply water to the populace*'. He however revealed that in Nigeria '*…people know that to get adequate water and constant supply of water, the best thing is to be independent of government just like supply of other infrastructure too in Nigeria. The government has failed virtually in all sectors, so people have to supply all infrastructural needs*'.

The supposition of '*failure of the State*' made by KI1 is hinted by the respondents interviewed in the course of the research and further corroborated by all the various key informants. Eight major factors were put forward as reasons for government failure in water supply and the management of water provision in Abeokuta in particular and in Nigeria in general. The eight factors include:

1. Wide range of unrealisable agency mandates
2. Lack of co-ordination between government agencies

3. Minimal involvement of the local government councils
4. Lack of proper planning
5. Problem of funding
6. Problem of water distribution networks
7. Erratic power supply, and
8. Problem of corrupt practices

This section highlights the eight point failure factors, discusses the implications of the factors on water management, and identifies the various proffered solutions.

11.2.1 Wide range of unrealisable agency mandates

KI1 in the dialogue presented in Box 11-4 citing the RBDA as an example suggests that many of the government water supply agencies are noted to have a range of wide and sometimes scattered functions. The outcome is unrealisable scope of duties that result in institution inefficiency. The insinuation made by KI1 is however attested to and better articulated by Akanmu et al. (2007). In the chronicles of the RBDA in Nigeria, the authors exclaimed '*The range of functions laid down for the River Basin Development Authorities (RBDA) in 1976 was extraordinarily wide. They encompassed irrigation, flood control, watershed management, pollution control, fisheries and navigation as well as activities remote from water resources, such as seed multiplication, livestock breeding and food processing. Their remit also covered a number of activities to be shared by state agencies, such as the provision of agricultural services and rural electrification.* ***However, in practice these hopes were not realized****. The RBDA have tended to concentrate on large scale single purpose projects, particularly irrigation schemes. The issue here became one of competition between the RBDA and the various State authorities. In other words, the interface was not managed properly, the roles, functions and co-coordinating mechanisms not defined clearly, and quite obviously far too much was attempted.* ***As a result the original goals and objectives were not attained and the erroneous notion developed that is the river basin approach was a disaster***'.

KI_1:	*Presently the orientation of the RB has been shifted from agriculture to water supply. The RB is responsible for the executive executing body for the federal government in terms of water supply. The RB is responsible for water at least they should be doing that and should be involved in things like this.*
I:	*Sorry to cut you in, do we have separate Ministry of Water resources now or is it still lumped with Ministry of Agriculture?*
KI_1:	*I think presently, the Ministry of Water resources is with the Ministry of Agriculture; we have the Ministry of Agriculture and Water Resources. The Ministry of Water Resources started out as a department under the Ministry of Agriculture then became an autonomous Ministry but now it is together with agriculture. The Ministry of Agriculture and Water Resources is responsible for the RB. So the RB reports to them. The RB is responsible for the development of water resources as against agriculture. Although it used to be the two (water and agriculture), but since the past 4 to 5 years, they have been focusing only on the development of water resources.*
I:	*Is that good or bad?*
KI_1:	*It is neither here nor there! Because if they have been able to perform the former perfectly well, then you can say remove that and replace with this but none of it is well developed. Otherwise, if they have been doing very well, we will not be here discussing this topic.*

Source: Research key informant interviews; I: Interviewer; KI: Key informant

Box 11-4: Problem of wide range of functions for water institutions

11.2.2 Lack of co-ordination between government agencies

The mandates given by the enactment of many of the water institutions is seen by respondents to often overlap with the functions of similar agencies across the three tiers of government. The result of duty overlap is usually un-coordinated agency functions. Un-coordinated agency function is particularly noted by KI3 '…*let me tell you another problem in public water supply system. The local government, state government and federal government they are all into water supply. The question is where is the meeting point? I am not sure that Nigeria herself has a master plan on public water supply, that's why today you see federal government sinking bore hole and tomorrow state government (in the same community) there is no master plan*'.

Lack of coordination in functions across agencies is also confirmed by Akanmu et al. (2007). Part of the earlier quotation from the authors explained '*The issue here became one of competition between the RBDA and the various State authorities. In* *other words, the interface was not managed properly, the roles, functions and co-coordinating mechanisms not defined clearly...*' Therefore duty overlap is direct result of un-coordinated actions.

The example of competition cited by KI3 - Federal government agency sinking borehole in the community where the State government sank borehole - is also corroborated by KI1 in Box 11-5. The exclamation in Box 11-5 however also indicates the danger in un-coordinated actions; that is failed water supply projects. Box 11-5 further infer another problem '*no one is interested*' in the failed water projects hence the '*whole place is dotted*' with non-functioning boreholes. The further inference pointed to the problem of accountability as no agency is interested nor held responsible for the failed water projects. As such un-coordinated functions lead to duplication of duties, failed projects and lack of accountability.

The problem of un-coordinated water supply initiatives may however be resolved. KI3 identified the '*absence of a water supply master plan*' as a cause of poor co-ordination among water agencies. The importance of the identification is that production of a water supply master plan may signify the key to function designation and defined coordination among water supply agencies. Coordinated designated function would also resolve duplication of duties and allow for accountability as the success or failure of a designated function can be traced.

KI_1:	*'…there are water projects from Federal government, but they are not functioning. And if I want to go to the extreme, I will tell you that even the borehole that is dug in front of the house of the President of this country (Immediate past president) functioned only for 2 or 3 weeks and since then it has ceased functioning and the president has not done anything about it. This is a statement of fact; it is there at Ita-eko.*
I:	*Are there no government agencies saddled with this responsibility?*
KI_1:	*Federal government for example has been operating through its parastatals, the so-called River Basins. The relevant River Basin for Abeokuta is Ogun-Osun River Basin Development Authority. Another statement of fact is that the immediate past chairman of Ogun-Osun River Basin also had a borehole right in front of her house there; I think that borehole functioned for maybe 6 or 9 months, it has ceased functioning, nobody had done anything about it. So if you could have such examples all around – the one in front of the president's house, the one in front of the chairman of the agency that is responsible for water supply has also failed and nobody is doing anything about them - then you can imagine what has happened to the others that are dotted all around the place that have ceased functioning, nobody is interested.*
I:	*What about in Ogun State Sir?*
KI_1:	*The examples I've given you are in Ogun State. The president's house is at Ita-eko here. The immediate past chairman of Ogun-Osun lives in Adigbe. The borehole in front of her house is not functioning; ….the borehole that is supposed to serve his neighbours did not function for a month and he couldn't do anything about it.*

Source: Research key informant interviews; I: Interviewer; KI: Key informant

Box 11-5: Problem of un-coordination among government water agencies

11.2.3 Minimal involvement of the local government councils

KI1 observes '*this is the government agency that is nearest to the people but (the agency) that is given the least responsibility...*' The respondent decries that minimal involvement of the local government at the heart of water provision development and management signify another factor for failure on the part of the government. The '*grass root*' role of the local government suggests that water supply and distribution should be routed through the local government areas and not necessarily by the State or federal government. Routing water supply and distribution may not preclude the production of potable water at the state level but rather suggests that distribution of public water through the local government areas may represent a better access and far reaching strategy. As more people, '*the masses – rural and urban*' would be more likely reached with public water (See Box 11-2).

11.2.4 Lack of proper planning

Lack of proper water supply planning is identified by KI3 as one of the major factors for failure of government in water provision (Box 11-6). KI3 explained that water supply is limited because of '*lack of proper planning*'. Population growth is forcing the city to expand but water supply is not commensurate with city expansion. Consequently the people within the '*new sites*' are not served with public water. Thus the problem of lack of proper planning is limited water distribution and supply. The respondent however identified '*finance*' as the cause of improper water supply planning (Box 11-6).

I:	*Which area are you now responsible for?*
KI_3:	*The urban and semi urban areas Abeokuta, Ijebu-Ode, all the bigger towns.*
I:	*In terms of percentage how much of these towns have you reached out to?*
KI_3:	*If I look into the statistics, generally I am sure the major towns we have reached out to them, but I cannot tell you that everyone has water in each town. For instance in Abeokuta it cannot be less than 75%, I am not talking about the new sites.*
I:	*What is responsible for you not reaching out to the new sites?*
KI_3:	*We are expanding, inflow of people day in day out but we are not really providing extension into those areas and that is part of the problem we have.* ***Lack of proper planning****, by now we should have laid pipes into all mini townships*
I:	*What is responsible for improper planning?*
KI_3:	*Finance, Public water supply is a real business*

Source: Research key informant interviews; I: Interviewer; KI: Key informant

Box 11-6: Lack of proper planning in water supply

11.2.5 Problem of funding

The problem of 'finance' is highlighted by KI3 in Box 11-6. The same problem is also mentioned by KI1 and KI2 in Box 11-7. From Box 11-7, the problem of funding is responsible for:

- Under utilization of water supply facilities (KI2)
- Lack of equipment (KI1)
- Limited water supply (KI2), and
- Stoppage of water quality monitoring programs (KI1)

The four highlighted resultants of poor funding are responsible for the public water shortage in the study area. KI2 explained that the capacity of the Ogun State Water Corporation is grossly under utilised because '*the booster stations*' needed to extend water distribution to as far as the neighbouring small towns are absent. KI3 in Box 11-6 is however more enlightening when he stated that even '*the new sites*' (newly developed city extensions) within Abeokuta are not served with public water supply as a result of poor funding. Likewise if the '*booster stations*' are not in place, apparently water supply equipment like pumps are absent. KI1 equally mention lack of water quality monitoring facilities and equipment (Box 11-7).

Apart from the cities, water provision to the rural areas is also limited by lack of funding. KI2 estimated that OGRUWATSAN has been able to provide 250 rural water schemes in its four years of existence out of the mandated 1, 175 boreholes (Box 11-7). The four years represent the period between agency establishment and time of research interview. According to KI2, OGRUWATSAN was established in November 2003. It should however be noted that limited supply of water to the intended is not static. The dynamics involves progressive increase in human population and consequently expansion in the recipient rural areas, towns and cities.

The stoppage of water quality monitoring is also noted as one of the consequences of poor funding. Invariably both the quantity and water quality management in the study area are impacted by lack of funding.

The government is however excused on the problem of funding by KI2 in Box 11-8. The respondent believed that the government is '*doing their best*'! The government '*knows that water is important*' as such water supply is usually prioritised. The government is however constrained for four reasons:

- Water supply is capital intensive
- Population growth
- Water supply is not the only social responsibility
- Lack of water supply budget appraisal

Consequently poor water supply funding is exonerated on the fact that water supply is capital intensive complicated by progressive population growth and considering that water supply is not the only social infrastructure '*promised*' by the '*politicians*'.

The real hindrance is however not in the first three constraints but in lack of water supply budget appraisal[41]. The constraint of lack of budget appraisal suggests that the government is not proactive in water supply management and budget planning. The first three highlighted constraints are dynamics needed to be factored into water supply budget planning. The factors are not to be treated as excuses for inaction. However lack of proactive approach is recurrent (Figure 6-9). It may be therefore appropriate for government to be proactive in water supply management approaches and in infrastructure budget planning.

KI_1:	*I will say that government have failed otherwise I would have thought that government is the best agent to monitor water quality. But I started my career by working in the Federal Ministry, I knew how we were doing it at that time and I know now that government agencies do not do it any longer* ***because of funding****.* ***They are not well funded****,* ***equipments are not there****. So, if one wants to embark on such monitoring activities now, I would suggest that tertiary institutions could be empowered to do that and if they are empowered in terms of materials and some funding, they probably have more at stake because the student could even have first hand practical knowledge of how these things are done and the interest is there for them to do it. I believe they could be more useful and more reliable than when you expect government to do that.*
KI_2:	*We have not gone to the definition yet! If we talk about the urban Abeokuta, the water scheme at Iberekodo is* ***presently under utilized*** *because the design of the scheme is to take water to as far as Obada-Oko, Ajebo, Odeda, and Kajola, but they have been unable to fully utilize it.*
I:	*Why is it so?*
KI_2:	***It is because of finances****. You need more booster stations to be in place, the NEPA (electricity) problem, and the population is increasing day in day out. As far as the rural areas are concerned, we cannot say that we have achieved anything. Now take for example when this agency came in, the proposal was for each Ward to have 5 boreholes; we have not gone to the half of that. We have about 235 wards in the state and if you multiply the figure by five it will be over one thousand and we have not gotten to 250.* ***This means we have not got to where we should be****.*

Source: Research key informant interviews; I: Interviewer; KI: Key informant

Box 11-7: Impact of poor funding on water supply management

[41] Update of proposed water project budgets to current or prevailing capital costs. The proposed or initial water projects budget is usually expected to change by the time the appropriation bill to approve (water) project is passed.

I:	*If I may ask you do you see any hope of managing water from source to point of use?*
KI$_2$:	***Yes, if only government wants to do it. Individuals do it, but only that water is capital intensive***
I:	*Do you see the concept of water safety plans being adopted by the government?*
KI$_2$:	*Yes**, if you see any counsellor now one of his priorities is water. They will say we will provide water for you; it's all about water, water**. No politician will say that water is not important. For example in Lagos you can dig loam and get water and if you go deeper you get the water quality that you need. **The government knows where the problem is they know that water is very important.***
I:	*If water is important to the government as you said, don't you think that the quality of such water should have been paramount?*
KI$_2$:	***Government is doing their best**; you know that the population in the urban city in Abeokuta for example the population is growing daily. When you decide a figure for 20 years you re-appraise, what has gone wrong is to improve on this. For example they want to do a water project, by the time they draw the bills you know water project is capital intensive and if you don't have water there is nothing you can do. You cannot blame them. **Water is not the only thing they promised to give**, they will consider other things like road, health, education, they will consider other infrastructural facilities as well*

Source: Research key informant interviews; I: Interviewer; KI: Key informant

Box 11-8: Respondent attempt to exonerate poor water supply funding

11.2.6 Problem of water distribution networks

KI1 in Box 11-9 catalogues the problems surrounding water distribution networks of especially the Ogun State Water Corporation. The sole responsibility of the Corporation is production and distribution of treated water to Abeokuta and environs. KI1 explained that the Water Corporation has two water schemes – the old and the new. He continued '*both schemes have enough water to go round the city and its environs but the distribution is the problem*'. The respondent enumerated five distribution problems as follows:

- The government neglected the extension of distribution network for too long
- Population growth exceeds the rates of distribution extension lines
- Existing distribution network is too old, faulty and leaking
- Poor documentation – distribution network maps not in existence
- Experienced personnel are retired or relieved of duties

Though the overall impact of problematic distribution system is restricted and limited water supply, each of the enumerated problems has peculiar impact on water supply management. Neglect of distribution lines extension and growth in human population over the rate of growth in the extension of distribution lines limits the supply of public water to areas of the city with old water distribution pipe lines. Limited water supply due to limited distribution lines is validated by KI2 and KI3. KI2 revealed '*I have my own borehole at home because Ogun State water distribution pipe network has not reached my area - Eleweran, very close to the Police head quarters*' in Abeokuta. KI3, a staff of the Water Corporation confirmed '*(Abeokuta) is expanding, inflow of people day in day out but we are not really providing extension into those areas and that is part of the problem we have; by now we should have laid pipes into all mini townships*'.

The implications of old, faulty and leaking existing pipe lines are two folds. Public water supply is limited to areas with functional pipelines. The public water being supplied with existing distribution lines is not necessarily safe for consumption. This research has established that the public water supply in Abeokuta is not necessarily safe for consumption (Table 7-2).

KI1 believed that possible intervention in distribution network problems is difficult for two reasons. Primarily due to poor documentation exemplified by the absence of network maps. And secondarily due to in-availability of workers who are experienced or involved in the construction of the existing distribution lines. The problematic distribution systems thus makes '*maintenance difficult*', the Water Corporation '*helpless*', and '*restricted the impact of government of today to giving people of Abeokuta water*' (KI1). That is there are three resultant impacts:

- Difficult maintenance
- Helplessness, and
- Restricted water supply

Intervention activities like maintenance of old distribution water lines are made difficult by especially the absence of network maps and experienced personnel. The

Corporation is in a state of helplessness because they do not '*know where to start from*' (KI1)! The Corporation do not '*know where to start from*' because firstly the construction of new distribution lines is '*astronomical in cost*'! Secondly maintenance of existing flow lines is difficult due to especially the absence of network maps. Such that the Corporation now have to rely on public information to trace faulty pipe lines and to locate leakages in water flow lines. The key informant with the Water Corporation, KI3 corroborated public involvement in locating faulty pipes or leakages. KI3 explained '*We have a department that goes out to collect revenue. They have other functions too; they mobilize and take complaints.* ***We encourage our clients to come and complain about leakages and burst pipes and through this we can detect earlier the areas that has problem***'. KI3 however claimed that '*We are good on that* (response to public complaints) *because quality is seen from the end user; consumer satisfaction is what the customers say*'!

Nonetheless, aside the enumerated system distribution problems and impacts, four possible solutions are suggested and inferred from Box 11-9. KI1 in Box 11-9 first advised on the re-appointment of workers who were involved in the initial construction of the existing distribution works as consultants. The consultants are expected to trace, map and document existing water distribution networks. The outcome of the consultant's assignments is expected to lead to the establishment of proper network documentation system. Other follow-on solutions include repairs of old pipelines, and investments in design and construction of extended flow lines. Finally the need for the Corporation to imbibe proactive intervention approach to water distribution management is implicit.

KI$_1$: *Water supply in Abeokuta had always been from the side of the government. It has always been the responsibility of government to supply water to the populace, but such action is limited to the urban areas. Teeming population living in the rural areas or outskirt of Abeokuta is excluded from the water supply and* ***that restricted the impact of government of today to giving people of Abeokuta water****.*

KI$_1$: ***I've always believed that there is enough water to go round even in a place like Abeokuta here. The problem has always been distribution network****. I know that in Ogun State here, the distribution network still in use now was put up between 1976 and 1978 when the State was created and since then, although the town has expanded to almost 3, 4, 5 times in size in the 1970s, water distribution network has not been improved upon. That is the old town and perhaps 2 or 3km from it on all sides that could enjoy safe treated water from government. Over half of the city is new now at least established maybe in the last 10 or 15 years and they can not even enjoy treated water even if there is one available because the distribution network is just not there, so there is a lot of work that has to be done on the part of government in the area of increase in distribution network which will carry water to the people.* ***The town has been growing at a faster rate than the government has envisaged or government has neglected the issue of extension of distribution network for too long.***

KI$_1$: *It is being said already that the supply of tap water from the Water Corporation is now even worse than it was last year.*
I: *Why?*
KI$_1$: *It is worse because the government is getting to be in a very helpless situation. They do not know what to do. It is not that there is no enough water, there is enough water but* ***the distribution network is very old****. They have to renew them and they do not know where to start from.* ***Most of the workers that are experienced enough to do the work are retired and some have been sacked****. Rather than try to get them back through contracts, appointments or appoint them as consultants so that they can show them where these networks are, what to do and so on, they are not doing that.* ***The whole system has been faulty right from the beginning. Documentation is poor****. For example, there are supposed to be maps showing the distribution networks, but such maps do not exist.* ***This makes maintenance very difficult. And you can not construct new networks because it is astronomical in cost****. These are the problems the Water Corporation or the government are faced with.*

The Water Corporations have two schemes in Abeokuta. We have the old and the new water scheme. Both schemes have enough water, ***but the distribution is the problem****. In fact this morning, I heard on the radio that the Water Corporation put up an advert that most of the water pipes are leaking and they want the inhabitants who discover leaking pipes to contact Water Corporations.* ***This means that the Water Corporation is helpless****. They can not locate where their networks are, they now rely on the inhabitants to inform them. That is the level of helplessness they find themselves, simply* ***because documentation has been poor right from the world go****.*

Source: Research key informant interviews; I: Interviewer; KI: Key informant

Box 11-9: Problems of water distribution networks

11.2.7 Erratic power supply

The inability of the government to provide potable water for all due to erratic electricity power supply is expressed by KI3. It should however be noted that the problem of erratic power supply is recurrent in this research. In his comments '*Although government wants to reach everybody but because of this electricity problem; for instance there is no light (electricity) since Friday. So it is only those who are supplied through gravity that has water but not so with the pump based supply line*'. KI3 continued '*government cannot give water because the power supply is not regular. For government to want to pump through generator it is big money*'.

The comments of KI3 highlighted four observations. The statement expressed the desire of the government to provide water for all. Erratic water supply is due to erratic power supply. The comments implied constant water supply to areas served through gravity flow, and expensive venture of water supply (pumping) through alternative power source. The importance of the observations is that the achievement of the government's desire – water for all – may hinge on the resolution of the energy sector. There is therefore an urgent need for the government to resolve the problems around energy provision in Nigeria to achieve adequate water supply.

11.2.8 Problem of corrupt practices

The problem of corruption in water supply practices is chronicled in Box 11-10. Water supply program features and is constant in government agenda. The proof of water supply constancy is '*the whole place dotted with boreholes*'. Water supply is constant in government's program because such projects are '*easy way of siphoning money*'. The evidence of money diversion is in the presence of many but non-functioning boreholes. The implication of '*many but non-functioning boreholes*' is limited water supply. As a result of '*corrupt government agencies and officials*', many water projects therefore equate to limited water supply.

The main impact of corruption highlighted in Box 11-10 is however '*loss of confidence*' in the government. The populace is reported in Box 11-10 to be suffering from what the author refers to as Confidence Deficiency Syndrome, CDS. As such the possibility of partnership between the government and source owners on especially water safety management is remote. The possibility is remote because according to Box 11-10 '*the government are notorious for being corrupt and unreliable*'!

The impacts of corruption namely limited water supply and confidence deficiency syndrome can be changed. Many water projects could result in improved water provision. Improved access to potable water could heal confidence deficiency only if the existing eyesore (i.e. corruption) is replaced hopefully with commitment. It is therefore a recommendation of this research that officials saddled with water supply responsibilities in the various government agencies change. Change from corruption to a more dignified commitment to assigned duties – in this instance the duty of water supply management.

Supply of water is a constant feature in the program of every government because it is an easy way of siphoning money. Since 1979, provision of water has been featuring prominently in the program of State, Federal and local government. The whole place is dotted all around with boreholes but most of them are not functioning because of ***corrupt government agencies and officials who could not effectively supervise the contractors after they must have*** *gotten money from them. So government is not lacking in programs that are meant for water but they have not been succeeding. Since 1979, I don't know how much has been spent now – 300 billion or so – since 1979 to date, up till this present moment, there are water projects from Federal government, but they are not functioning.*

Government-owner relationship or collaboration - I don't see that working because it seems people have lost confidence in government and the government workers are notorious for being corrupt and un-reliable and I don't think that private people will take government seriously enough to want to empower them to do that kind of operation. The confidence is not there.

Source: Research key informant interviews (KI identification anonymous to protect source)

Box 11-10: Corrupt practices: factor for failure in water provision

11.3 The Public Health Department

The Public Health Department, PHD is an arm of the Ministry of Environment. The Department however functions at the Local Government Council level. In chapter 10 the PHD was frequently identified by respondents as the government agency to shoulder the responsibility of water safety management of self supply systems, SSS. One of the key informant, KI1 argued that '*the government will not want to do it* (manage water safety of self supply systems or create the awareness involved) *but the money is with them* (the government). He argued further '*If you say the Landlords* (or source owners) *should create the awareness, where would they get the funds from because they will need some funds*?' The problem of funding, which emerge from the argument threw the responsibility of water safety management of self supply systems back to the government.

When asked to clarify the potential role of the PHD in water safety management of SSS, KI1 reveals '…*but they* (PHD) *are not effective*' (Box 11-11). Further remarks of the respondent in Box 11 imply the following:

- The PHD are not strangers nor new to the proposed role
- Current state of invisibility is due to relegated role and lack of enabling facilities
- The government (federal and state) are responsible for the invisibility state of the PHD
- Government readiness to reinstate the PHD, and
- Public (water users) compliance to government directives

The phrase '*they* (PHD) *used to*' in Box 11-11 infers that the PHD are in effect not new to the proposed role of managing public and environmental (water) safety. KI3 while justifying the deployment of the Department to the Ministry of Environment declared '*we are Environmental Health Officers*'. Thus delegating water safety plans of SSS to the PHD would mean that the Department would be engaging in the function for which it was established.

To validate the submission made above, KI3, a Chief Environmental Officer confirmed that PHD is rightfully identified by water users (Box 11-12). The officer explained that the five primary roles of the PHD are water quality monitoring (household and commercial water), environmental inspection and household visits, and public education (conducted through house-to-house visits and awareness campaign). The other roles are to resolve public complaints via the Public Complaints Unit of the Department, and prosecution of non-compliance to environmental guidance (Box 11-12).

Public compliance to government directives is corroborated by KI3 in Box 11-12. KI3 in explaining the functions of the PHD also used the phrase '*used to*'. The respondent in her explanations suggest that the PHD '*used to*' be well known in the public domain such that '*…the fear of sanitary overseers is the beginning of wisdom*'. However, the presence of the PHD is no longer visible due to in-effectiveness. KI1 in Box 11-11 and KI3 in Box 11-12 both admitted to ineffectiveness of the Department. The ineffectiveness is due to the absence of enabling facilities among other factors. The various identified factors are discussed in subsequent section. KI1 accused the government of the ineffective and hence invisible state of the PHD while also noting the readiness of the government to reinstate the Department. Government readiness to reinstate the PHD is however a recent development.

KI_1:	*Public Health Department, yes they are with the LG but they are not effective. They used to be very effective in those days, especially in Lagos, but nowadays, they are not effective. However the State Government has realised that the PH department should come back on-stream, but I do not think that there is enabling tools to work with.*
I:	*Many water users claimed that they will comply with PH workers' directives on water safety even though the SSS are not provided for by the government*
KI_1:	*Well, people will comply with government directives. That is if the government sends the PH workers, the people will comply*

Source: Research key informant interviews; I: Interviewer; KI: Key informant

Box 11-11: Current functional state (ineffective and invisible) of the Public Health Department

KI_4:	***PH workers used to be very effective***
I:	*That line is really very common. I have heard same statement being said to me repeatedly, so what changed?*
KI_4:	*In the past when the level of education is not so high, what the sanitary overseers know is that insect larvae must not be found in a water pot. The people as well are not learned and not so civilised,* ***so for them the fear of sanitary overseers is the beginning of wisdom.*** *Many of them, even though do not know the implication of what the SO are doing, yet they feared them a lot. It is so bad that as soon as they sight any SO, will drop their water or whatever they are doing and run from the SO. In these modern times however, things are different.* ***We do more of health education because there is a limit to how you can harass people.***
I:	*How do you conduct such health education?*
KI_4:	***We do house-to-house health education during sanitary inspection visits*** *to detect nuisances and to abate them*
I:	*What do you mean by nuisances?*
KI_4:	*Nuisances are anything that is injurious to public health, anything. For instance, if there is a puddle of water here that can breed mosquitoes, and you know that mosquitoes can transmit malaria, then that is a nuisance. Or in a house where there is no drainage system, that is a nuisance. If there is no toilet, that is a nuisance. There are some nuisances that you can abate summarily i.e. by giving an oral notice. For others you may need to give abatement notice.* ***If the people now fail to comply with the terms of the abatement notice, then you may need to prosecute them.***
I:	***Do you have the jurisdiction to serve abatement notice and to prosecute?***
KI_4:	***Yes we do and we do that on a regular basis***
KI_4:	*Yes, it is only* ***during inspection that you can look into household water…but handling public complaints alone is enough work****.*
I:	*What are the types of complaints?*
KI_4:	*For example, someone digging a toilet near your window, people come to complain. Another example is building a commercial business shop to bar a resident's window. Complaints like that. No toilets and throwing of faecal matters to create a nuisance*
I:	*So from what you are saying the PH officers are active?*
KI_4:	*yes, we are busy but not many*

Source: Research key informant interviews; I: Interviewer; KI: Key informant

Box 11-12: Highlights of the five primary functions of the Environmental Health Officers of the Public Health Department

11.4 Invisibility of the Public Health Department

Six factors are identified for the ineffective state and hence invisibility of the PHD (Table 11-1). The factors are people induced but mostly government induced. Invisibility of the PHD is mostly caused by the government. Only one of the six factors reflects the impact of the end users on the ineffective state of the PHD (Table 11-1). The number variation suggests that the onus lies more with the government to create an '*enabling*' environment for the PHD to function and tackle the people problem. The six factors are discussed in turn.

Table 11-1: Factors responsible for invisibility of the Public Health Department

Invisibility factors	Categories
Manpower problems	Government induced
Obsolete public health laws and sanctions	Government induced
Political problems	Government induced
Conflict of agency roles	Government induced
Lack of stakeholder involvement	Government induced
The people problem	People induced

11.4.1 Manpower problem

The major manpower problem in the Public Health Department is inadequate number of personnel. KI3 referred to it as '*grossly inadequate*' (Box 11-13). In Ogun State with about 250,000[42] people, KI3 claimed that there are only about 200 environmental health officers (Box 11-13). The declared figure shows that one PHD staff member is responsible for about 1,250 members of the population. The estimate shows that

[42] Approximate Ogun State population figure from 2006 national census

indeed the PHD is grossly under-staffed and explains the reported ineffectiveness of the Department. Given the various functions of the PHD, KI3 queried '*it is only during inspection that you can look into household water.* ***But how many houses do few officers want to enter?*** *In Abeokuta south* (Abeokuta city and suburbs are in Abeokuta south LGA), *handling public complaints alone without going out for inspection is enough work*' (Box 11-13). Implicitly, effort of the PHD would not generate desired impact due to the grossly under-staffed problem.

The problem of under-staffing in the PHD is further reflected in five different but related dimensions. The first inherent problem is that PH officers are in a tight spot with time and duty management, which results in neglect of certain duties. A second but related dilemma is '*officers prefer to stay in the urban areas*' (Box 11-1). The dilemma implies that small towns and villages (rural areas) may all the more be neglected and cut out from the functions of the PHD. The third problem relates to poor training programs for up-coming staff members. It is difficult to train the starter staff because there are no middle ranking officers. Consequently starter staff are not knowledgeable in the roles and jurisdiction of duties. Absence of middle rank officers thus represents the fourth problem. The fifth but tricky resultant effect of being under-staffed is under-utilization of PHD staff.

KI3 decry under-utilization of the PHD (Box 11-14). The respondent claimed that the Department is one with various fields of expertise and brilliant brains. The fields of expertise and the wealth of knowledge within the Department are however not utilised effectively. The knowledge areas and skills are not effectively utilised because the government do not allow the Department to function in job areas, which the Department have expertise for. The government either hires new recruits to do PHD related jobs or engage contractors to perform PHD related functions. The described government activity amounts to under-utilisation of the PHD and is viewed by KI3 as '*waste of resources*' to reward or secure electoral votes.

The problem of under-utilization is tricky because the PHD is grossly understaffed. Additional line of duties may signify more pressure of work on the already under-staffed work force. The argument however is that the department be allowed to function in its areas of expertise and not to be incapacitated by hiring non-PHD personnel or sub-letting PHD functions. As a solution however KI3 suggests that financial resources that are being wasted on recruitment of non-PHD personnel be channelled to procure material and human resources to revitalise the PHD.

KI_4: *'…some public health workers as well do not even know their rights. In my unit, I have to educate workers of their jurisdiction and rights.*

Again, how many are we? It was only last year that the governor employed more hands and even at that, we are still only about 200 officers. In the whole of Ogun State of 20 LG areas, we are about 200, so how do we cope with the pressure of the work? There was a time that we were only 7 in Abeokuta South LGA. Of the 7, five of us are Chiefs. For instance, with my position, I am not supposed to go out again for inspection. Once you rise to an administrative position but sometimes because of the situation of things, I do go out with the team. At Imeko-Afon LGA, we about 8 officers on level 7, none on levels 8, 9 and 10. Officers prefer to stay in the urban areas. The remaining 5 of us are chief inspectors and head of units and departments. We have administrative work on a daily basis, so we do not go out, but we have to.

Even the newly employed level 7 officers; we do not have the middle ranks officers of 8, 9, and 10 to train them. Just two weeks ago, students were sent to us for training. I have to go into my archives looking for materials and papers to deliver because I don't really trust the in-experienced officers. They can not handle them.

I: *So you are saying that you have a major problem of man power*

KI_4: *Yes, we do….You can do the calculations to see that the manpower is grossly inadequate. And the population is increasing.*

KI_4: *Yes, it is only during inspection that you can look into household water. But I have talked about the manpower problems. How many houses do few officers wants to enter. In Abeokuta South, handling public complaints alone without going out for inspection is enough work.*

Source: Research key informant interviews; I: Interviewer; KI: Key informant

Box 11-13: Manpower problems in the Public Health Department

KI_4:	*When I was in training, abattoirs are one of the places we go for training. Learning animal glands, what to look for in animals to prevent public health. The various types of animal diseases like anthrax, etc. Later on however, we were told that abattoirs inspection is the duty of the veterinary medical officers! All political gimmicks!* *But it is so unfortunate. They see you as threats, as people who know nothing but the truth is that **we (PH department) are underutilised**. There are many of my senior colleagues that are so brilliant. You need to hear them speak**; we are indeed under-utilised.*** *Government recently awarded a contract to a private company for emission control. The head of the company recruited some un-employed graduates, trained them up for the job and send them out without any prior experience. Meanwhile, emission control is one of my areas of specialization, up to Masters Level. What I am saying is that the government do not need to spend extra in terms of man power to resolve the issue of emission control. The man power resources needed are available within the government work forces. The human resources are there, what we need is material resources. The government do not need to waste resources on further acquisition of human resources. This is also one of my recommendations in the communiqué. But because they want to find food for people who voted or sponsored their electoral ambitions….that is another problem.*

Source: Research key informant interviews; I: Interviewer; KI: Key informant

Box 11-14: Under-utilisation of Public Health Department

11.4.2 Obsolete laws and sanctions

The PHD functions are guided by what is referred to as '*the public health laws*, PHL' in Box 11-15. The PHL document specifies what constitutes public and environmental nuisances, control measures, and processes of abatement and sanctions to enforce compliance. It is however evident from the documented stipulated fines and sanctions that the public health laws dates back to the national pre-colonial era (Box 11-16). Fines are required in pounds and shillings – the pre-colonial national currencies[43]. Sanction fines expressed in pre-colonial currencies also signify that the laws have not been reviewed or up-dated. KI3 complained that the public health laws are obsolete and out of tune (Box 11-15). Obsolete laws and sanctions make prosecution and

[43] In pre-colonial era, £I is equivalent to 20 shillings. One shilling is equal to 12 pence

enforcement difficult. Pre-colonial currencies are difficult to convert to the current legal tender (Naira). Attempts to convert stipulated fines to current currency equivalent also usually yield currency values too low to worth the trouble of prosecution. KI3 cited a fine of 50 naira (£0.2) stating '…*and you go to court over matters that attract such ridiculous fines…*' Thus the offenders especially the enlightened easily get off the hook. NPHL (1957) confirms that the laws are enacted and documented 1 August 1957 approximately three years before the national independence.

I:	*Could you please explain to me the process of your court procedures? Are lawyers involved like in normal court proceedings?*
KI_4:	*We have lawyers that can stand in for offenders as prosecutors. But the enlightened ones do come with their lawyers. Their lawyers could represent them. That is why you have to be careful as PH official. You have to make reasonable presentation of your case because the law is there you can not just write rubbish.* *That takes me to another set of problems – the public health laws. Many of the laws are obsolete. So we have to be very careful to prosecute nowadays. In public health laws where the fines are N50.00 naira (£0.2), one shilling (currency before Nigerian independence in 1960) and all ridiculous amounts of money, and you go to court over matters that attract such ridiculous fines. How do you convert pre-colonial currency? Things are a bit better in the rural areas where the people are not so knowledgeable, people will not be probing. Where the people are enlightened like the urban centres, you have to be very careful.*

Source: Research key informant interviews; I: Interviewer; KI: Key informant

Box 11-15: Obsolete laws and sanctions

> If a person fails to comply with the provisions of nuisance order with respect to the abatement of a nuisance he shall, unless he satisfies the court that he has used all due diligence to carry out such order, be **liable to a fine of one pound a day** during this default; and if a person knowingly and wilfully acts contrary to a prohibition or closing order he shall be **liable to fine of two pounds a day** during such contrary action; ….

Source: Chapter 103, section 8, sub-section 9 of the Nigerian Public Health Law, 1957

Box 11-16: Excerpt from Public Health Law

11.4.3 Political problems

Another major incapacitating problem for the PHD is political problems (Box 11-17). KI3 claimed that political problems are triggered in two ways. The first is '*when you serve abatement notices*' to the elite or on legislative residences. The second occurs when the named groups are sued (Box 11-17). The consequences of political problems are also twofold. KI3 exclaimed that officers are either queried or embarrassed, suggesting political patronage. The influence of political patronage is hinted by KI3 '*…most of them are your employers…*' Either way, the consequences of political patronage are not palatable for the PH officials. The second influence of political problems is '*…judgements go in favour of the offenders*', insinuating not only the abuse of power through political patronage but also bribery and corruption practices in prosecution proceedings. The over riding impact of political patronage is however the difficulty of enforcing compliance of public health laws amidst especially the elite and the law makers.

The respondent noted political problems as '*plagues*' from '*within*', which requires '*tact*' in resolution (Box 11-17). Tactful resolution however seem to lie with political will. That is the resolve of the political (or public) office holders to uphold law and order especially and first within the political circle. Unfortunately the respondent further claimed that there is no political will (Box 11-18).

Lack of political will represent another dimension in the political problems plaguing the PHD. KI3 in Box 11-18 reported the almost impossible tasks and processes of getting new or amended bills passed to adoptive by-laws at the local government councils. The respondent claimed that public health bills may take forever or not be passed at all by the legislative councils. This endangers the public, in a similar way to car accidents caused by straying animals[44], and inhibits PHD functions.

Absence of political will is linked with especially the educational status of political office holders. Many of the political appointees are either without any form of formal

[44] Un-caged domestic animals like goat do stray on motorways to cause car accidents

education (illiterates) or are semi-illiterates (Box 11-18). As a result the political appointees do not '*know what to do*' (KI3). The consequences of lack of knowledge within the political circle are intertwined. Professionals whose efforts and advices are ignored and rubbished are frustrated from lack of job satisfaction. Lack of job satisfaction in turn leads to professional erosion or brain drain. KI3 stated '*I would have resigned because there is no job satisfaction*'. Knowledge is thus critical to political will and hence to public governance and safety management. It is therefore recommended that an appropriate minimum formal educational standard be stipulated for public office holders serving in any political appointment or post.

KI_4:	*In elite areas, the problem of overgrown weeds is common.* ***When you serve them abatement notice however, you trigger off the political problems.*** *By the time you get to the office, you may have about 5 letters already waiting for you! Claiming why you have to serve abatement notices on one legislative residence or the other*
I:	*How do you deal with such political problems?*
KI_4:	*The issue is that most of them are your employers, so you have to be tactful. There was a time when a colleague of mine went for inspection at Ifo and confiscate exposed bread. After a complaint by the bread sellers to the LG chairman, the chairman asked the officers to return the bread. Claiming that he has been eating such bread long before the officer was born.* ***So we are plagued with such embarrassment from both within and without.***
I:	*Would there ever be a consensus over anything in the country then?*
KI_4:	*So far I can say that there is only one particular LG chairman that I have enjoyed working with. This was at Sagamu LGA, indeed I was surprised. Often you will find this chairman after making an arrest call on the public health officers to come and take over. There was an instance when he called on me that he just caught someone dumping refuse in an un-authorised location. He did similar things on at least 3 occasions before I was transferred from the area. So I can say that we enjoyed the co-operation of the LG chairman at Sagamu. In other areas however, even the councillors will embarrass you for doing your job. So you see that this is also another type of problem and you have to handle with care.*
	Sometimes also you will get to court and even the president of the court before you know it 'things' would have exchanged hands behind your back (implying bribery of the judges) and judgement will go in favour of the offenders. Really we have a lot of problems.

Source: Research key informant interviews; I: Interviewer; KI: Key informant

Box 11-17: Political problems: the influence of political patronage in the Public Health Department

$KI_{4:}$	In some cases the LG are allowed to make adoptive by-laws. Sometimes in Yewa north LGA, we have the problem of stray animals. Stray animals (cows, goats) can cause accidents; in fact they cause accidents on roads. So I put up a bill to the House (of assembly within the LG) for adoptive by-law. I ended up spending 7 years in the LGA. Up to date the bill has not seen any light. It was one excuse after the other. Many of those politicians do not even know what to do. Many are not even learned. Some of them are illiterates, some semi-illiterates; these are the people sworn-in, can you imagine? There are so many things that need to be done, many projects, so many initiatives to explore, but the political will is not there! These are the problems, these are our experiences. Even the issue of refuse collection is the statutory duty of the LG. The State government had to take it over from the LG. If you write proposals to the LG chairman, they are not interested. They prefer to do something else like build class rooms and embark on projects, which they can commission and which the people can easily see that they are doing something. The State government now deducts certain percentage of the LG fund allocation per month for refuse collection. They prefer that, can you imagine? Can you imagine a LG without rakes and cutlasses and there are people to work. Really if I have the opportunity, I would have resigned because there is no job satisfaction. You know what to do but there is no political will on their part to do anything. It is indeed political will. As professionals we know what to do but they are not ready. It is only what the politicians' want that they do……..
I:	So the political will is another big problem
KI_4:	Yes, it is.

Source: Research key informant interviews; I: Interviewer; KI: Key informant

Box 11-18: Political problems: lack of political will

11.4.4 Conflict of roles

Problems generated by conflict of roles among relevant regulatory agencies are highlighted in Box 11-19. Box 11-19 reveals that regulatory bodies (e.g. PHD and NAFDAC) struggle for control of especially the commercial water providers. The example of regulatory control of commercial water providers between NAFDAC and PHD reveals two fundamental control issues:

- Government support or backing
- Jurisdiction or scope of duties

NAFDAC believes the agency enjoys the backing or support of the government and hence the regulatory control of commercial water providers. The commercial water providers will also rather comply with NAFDAC stipulations than abide with PHD regulations. This means that PHD is denied access to function in regulatory capacity (Box 11-19). The issue around government support is therefore indicative of the importance or weight that government support bears on regulation compliance. The public tends to toe the line when the government throws their weight behind regulation. Hence success or effective regulation is achieved with government support. From Box 11-19 however, government support is not only needed in the provision of enforcement backing or empowerment but also in provision of resources (human and material). Adequate resource provision is crucial to enhance or facilitate effective regulatory functions of relevant agencies.

It is however important to note that equivocal government support of regulatory agencies is damaging. Box 11-19 reveals the means employed by the commercial water providers to circumvent NAFDAC regulations. NAFDAC inspection of water production facilities is stage-managed by ensuring the sampling of '*good water*' at inspection. Subsequently, sub-standard water quality is produced and distributed for commercial purposes. Commercial water providers are generally expected to secure NAFDAC approval to retail water. NAFDAC approval is however usually secured after due inspection of office, production facilities, and hygiene and safety practices employed in water production processes. Consequently, the public is exposed to purchase of sub-standard quality drinking water and at relevant health risk. Table 7-2 previously reveal that the quality of some of the sachet (pure) water distributed for sales as drinking water in Abeokuta is not safe for consumption (Chapter 7).

It thus becomes necessary for the government to provide an unbiased and unequivocal support to every regulatory agency. Adequate and fair support can however only be provided if regulatory functions are specified.

The problem of jurisdiction is hinged on clarity of roles and functions. Water production facility inspection to secure NAFDAC approval, and environmental cum public health inspection to ensure compliance with public health laws by the PHD are seen by especially the commercial water providers as one and the same. The two types of inspection are unfortunately also seen by the agencies involved as one and the same. There are however differences. NAFDAC approval is mandatory for the establishment of any commercial drinking water distribution plant. PHD is however not required to issue approval for compliance to public health mandates. Rather, PHD ensures compliance through monitoring (Box 11-19). Likewise while monitoring connotes continuity (frequent or repeat exercise); securing approval denotes a one-off requirement exercise. The inspection activities of either NAFDAC or PHD are therefore similar but different. The end result of the inspections differ, the frequency of inspection also varies.

A meeting point can however be derived. Reports of the PHD monitoring exercises could be made available to NAFDAC to review and assess approval procedures and requirements. Approval reviews would then short circuit the circumvention practices of the regulated and also block the various existing loop holes that are currently being exploited by the regulated. There is therefore the need for clarity of roles and functions among regulatory agencies.

KI4 noted in Box 11-19 '*the public health problem is multi-sectored and there should be a multi-sector approach to it. No single body can handle it. There should be a link between all the sectors. The health officers know what to do, the NAFDAC as well knows what is expected of them*'. The required link may ensue through communication and access to outcomes of monitoring programs. As suggested above, findings from monitoring programs should be documented and made accessible to relevant regulatory bodies by the PHD.

KI4 also suggests '*so let the government call us together to specify roles of individual agencies. Let them also create awareness for the people such that they will know which agency collects water samples and which one does the water quality monitoring*'. From the suggestion, the government in their capacity as agency (or policy) formulator is responsible for role clarification. It is also the role of the government to enlighten the public on defined roles of individual relevant regulatory agencies. The public should be cleared on similarities but also differences in regulatory roles and comply accordingly.

KI_4:	*You see, there are so many policies, ok let me cite an instance. If you visit a 'pure water' company as a health officer for inspection, they will tell you that you are not a NAFDAC officer. This is one of the problems we are facing. There was an instance at Imeko-Afon LGA when we were told that we are not NAFDAC officers. Even some public health workers as well do not even know their right. In my unit, I have to educate workers of their jurisdiction and rights.*
I:	*Is there no clear or distinct work or line of duty between the public health workers and NAFDAC officials? Do NAFDAC see you as a threat or rival or vice-versa?*
KI_4:	*NAFDAC believed that they (the government) have given them the law and are empowered to handle water. NAFDAC collects water samples of these water companies (commercial 'pure water' and bottled water companies). And you see there is a way they do these things. Our people are very cunning. The companies will ensure that the first sample that NAFDAC collect is good water. Subsequently you will see sediments in water that is produced for consumption after NAFDAC approval. In order words, the policy (formulation) problem is there.*
	We had a workshop some few weeks back and we use to write communiqués but where do such communiqués ends up? In this particular workshop, I emphasised the need for the communiqué to see the light. The public health problem is multi-sectored and there should be a multi-sector approach to it. No single body can handle it. There should be a link between all the sectors. The health officers knows what to do, the NAFDAC as well knows what is expected of them. This was the message at the workshop.
KI_4:	*You need to see the rickety vehicles that NAFDAC officers use for their duties. With that type of tools, where can they get to? So let the government call us together to specify roles of individual agencies. Let them also create awareness for the people such that they will know which agency collects water samples and which one does the water quality monitoring. As it is however, no one can stop me from getting to any company or factory for inspection.*
I:	*Well, that is another of my worry; it seems like all the water sectors are eager to get into commercial water providers. What happens to the individual water sources, the household sources?*
KI_4:	*Yes, it is only during inspection that you can look into household water. But I have talked about the manpower problems. How many houses do few officers wants to enter. Either the health workers or NAFDAC officials, how many are we?*
KI_4:	*We used to collect tap water samples too in the past for testing to make sure that they are safe for public consumption, sometimes on weekly basis. That was when you enjoy your work as a PH officer. All the taps, all the water sources then but that was when you do not have so many agencies in charge of water. Today if you try that, they will ask you if you are from NAFDAC. Now we thought NAFDAC is responsible for water and so on. But really, it is our job*

Source: Research key informant interviews; I: Interviewer; KI: Key informant

Box 11-19: Conflict of regulatory roles

11.4.5 Lack of stakeholder involvement

Lack of stakeholder involvement is recognised as another major problem to invisibility of the PHD (Box 11-20). The PHD are usually sidelined and excluded by the government from policy formulation and implementation. The government in this instance is identified as the politicians and the government officials – the policy formulators (Box 11-20). KI4 explained that the PHD becomes aware of policies through the media without prior consultation or involvement. Exclusion of PHD in policy formulation and lack of consultation with the PHD on policies, which relates to public and environmental safety, had precluded the PHD from influencing formulation and policy implementation strategies. Consequently, many policies had failed, suffered set backs or been poorly implemented.

Aside the exclusion of PHD in policy formulation or implementation, the phrase '*the public is not ready for this*' identifies the public as the second key stakeholder in policy management and implementation (Box 11-20). Thus policies fail or suffer set backs because the PHD and the people are not involved in formulation.

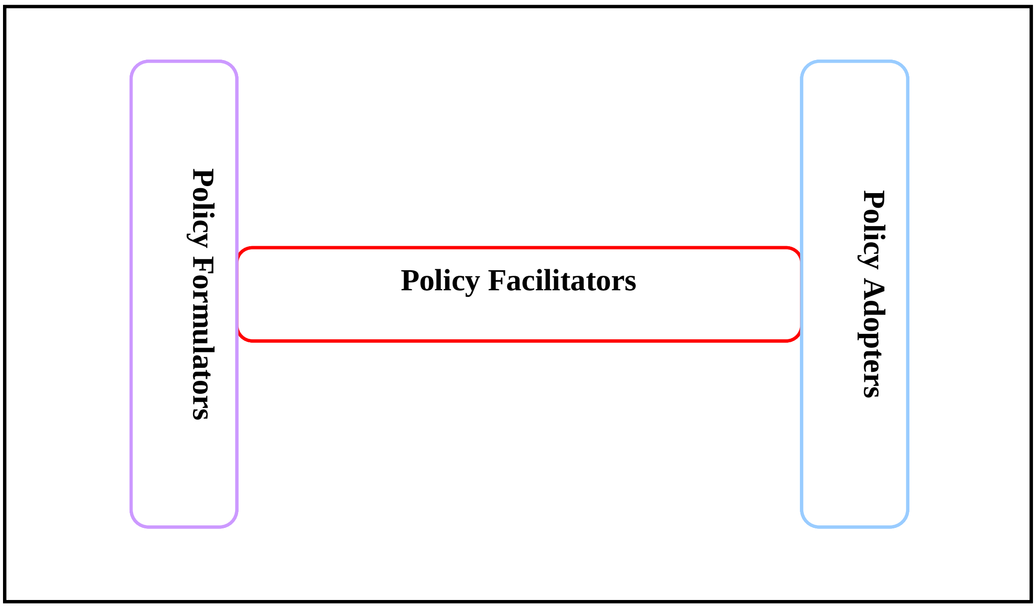
In the example of the failed solid waste collection program cited by KI4 in Box 11-20, the respondent queried '*is it someone who can not afford N200.00 (£0.8) to cook a decent meal that you will ask to pay for refuse collection? It is only within the elite that you can get some co-operation. All the others are not ready to pay for refuse*'. From the statement two policy adoption factors are highlighted; socio-economic status and end user readiness. The adoption factors represent hurdles to policy up-take and hence are critical to policy adoption.

However the PHD is familiar with the adoption factors. The PHD is accustomed to the socio-economic status of the people. Public readiness can also be gauged by the PHD. The PHD is familiar with the situation of the public because the department relates with the people. KI4 stated '*we have meetings regularly with the public*' and as such '*we know how to talk to the* people'. The PHD '*knows how to talk to the people*' not only because it is their duty to talk to the people but also because they are trained to relate with the people. Thus for policies to be adopted by the people, the PHD knows what to do.

Two adoption methods are usually employed by the PHD. The remark '*there is a way to go about doing such things. We* (PHD) *can encourage the people. We* (PHD) *can ask them* (Public) *to combine households and even partner with them to support their effort*' reveals public encouragement, and household support strategies. Examples of household support strategies include combination of two or more households, and household-PHD partnership in policy implementation. Thus the PHD can work around both the immediate or impending policy hurdles to achieve policy adoption.

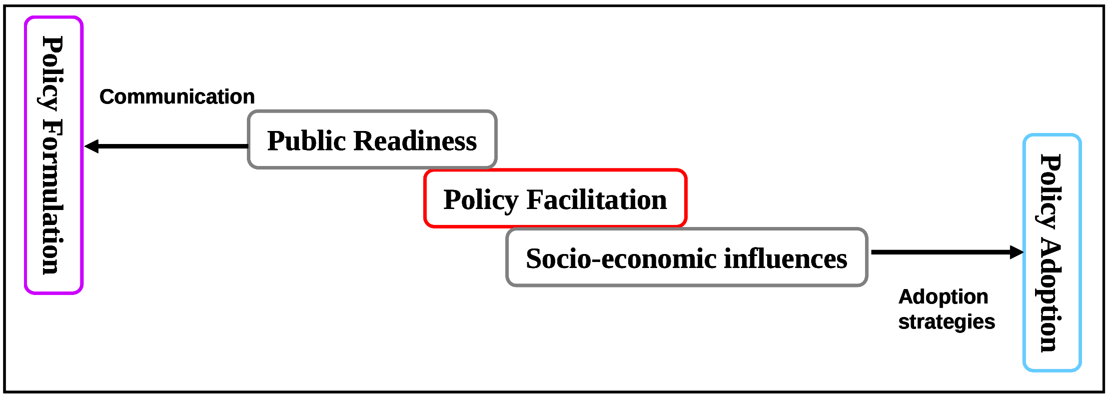
Invariably, while the people are the eminent policy users or adopters, the PHD can be regarded as policy facilitators. Thus to move policy from formulation to adoption there is the need to involve the policy adopters and cross adoption hurdles. To involve the adopters and cross adoption hurdles, there is the need to involve policy facilitators to apply adoption strategies. The first facilitating role of the PHD is government notification of public readiness to policy adoption. The second facilitating role is to work around the socio-economic status of the people through any of the adoption strategies. The three tier stakeholder involvement scenario can be represented using the author's H model for effective policy adoption (Figure 11-2). The hurdle crossing and facilitating role of the PHD also sit within the H policy adoption model (Figure 11-3).

To further correct the error and reverse the consequences of lack of stakeholder involvement, KI4 opined '… *public health issues cannot be handled by a single agency. All stakeholders have to come together. Let there be a forum where all stakeholders will meet and specific duties will be assigned for each stakeholder*'. In other words aside the three highlighted stakeholders in Figure 11-2, KI4 suggests the involvement of wider stakeholder group through platform or forum participation to among other things define stakeholder involvement, functions and roles.



Source: Author’s concept

Figure 11-2: Three tier stakeholder involvement (H model) for effective policy adoption



Source: Author’s concept

Figure 11-3: H model: Hurdle crossing and facilitation roles of the Public Health Department

KI$_4$:	*Again when they want to formulate or enact all those policies,* ***the relevant stakeholders are never involved****. For instance, when they started the household refuse collection, we just heard it on the radio. The PH department was not consulted, we were not involved. And you see, we know how to talk to the people. Are the people ready to pay the refuse collection rates and so on? The public is not ready for this. It is only within the elite that you can get some co-operation. All the others are not ready to pay for refuse. Is it someone who can not afford N200.00 (£0.8) to cook a decent meal that you will ask to pay for refuse collection?* *But there is a way to go about doing such things. We can encourage the people. You can ask them to combine households. For instance in the case of asking households to build toilets, we combine households and even partner with them to support their effort, especially in the rural areas. We have meetings regularly with the public.* *There really is a problem. Government officials, politicians just sit down in their offices to formulate policies; policies that have no bearing with or on the people. The health workers will go out, interact with the people, they know what is happening. Yet the government will never consult them. Anyway experiences are now forcing the government hands to start to involve at least the people, the end users. A well was once commissioned by a lady commissioner in one of the LGA. Unknown to them, there is a taboo in the community that prevents inhabitants from taking water from any source that a woman takes water from first. After the commissioning off course the water source was abandoned. No one touched the borehole or took water from it. Wasted effort, wasted resources. It later took an insider to understand the problem.*
KI$_4$:	*We need to do something. On my part, let us hope that the communiqué we submitted a few weeks back will achieve something. We recommended in the document that public health issues can not be handled by a single agency. All stakeholders have to come together. Let there be a forum where all stakeholders will meet and specific duties will be assigned for each stakeholder.*

Source: Research key informant interviews; I: Interviewer; KI: Key informant

Box 11-20: Lack of stakeholder involvement in policy formulation

11.4.6 The people problem

The people problem is categorised into three broad groups.

- Problems due to time restriction and socio-economic limitations (Category I)
- Problems due to Confidence Deficiency Syndrome – The disease, (Category II)
- Anti-regulatory practices (Category III)

The category I problem are twofold; the problems due to time restriction and socio-economic limitations. People problems due to time restrictions relate to limitations generated by the official working hours of the PHD. The public health law stipulated a 6am to 6pm working hours for health officer (Box 11-21). However KI4 complained '*…you may not meet people at home when you visit the elite areas during working hours. So what we do often is visit places like the rural areas or where there are illiterates. Chances are that you will meet them at home and usually, these set of people are dirty too*'. The complaint suggests limitation in the scope of work and performance of the PHD. PHD functions are restricted to locations where the chances are to gain access for inspections. The existence and the activities of the PHD are thus invisible in areas, which the PHD cannot access during the official working hours.

> It shall be stipulated for the health officer to enter any premises at any time between the hours of six in the morning and six in the evening for the purpose of examining as to the existence thereon of any nuisance, or until a nuisance found to exist has been abated or the works ordered to be done are complete….

Source: Part II, section 10, sub-section 1a, Public health law, 1957

Box 11-21: Stipulated working hours for public health officers

The second category I problem is due to socio-economic limitation. The PHD functions are limited due to the poverty level of the people. KI4 explained '*Then you inspect and begin to advise that 'please you will need to make some repairs or work on that area', but you will also wonder at the scenario. The state of most people are so pathetic for the level of poverty that you will think to offer them N500.00 (£2) to help them than asking them to look for funds to repair insanitary conditions of wells. Hence, you have to use your discretion. The situation is really bad*'. The respondent noted the insanitary conditions of water sources. She however equally decried the pathetic state of the populace due to poverty level, which makes it difficult to enforce compliance to public health regulations. To ensure especially the sanitary conditions of water sources, KI4 advised discretion. Discretion is exercised through the usage of regulation compliance strategies (or discretion devices). Two discretion or regulation compliance strategies are developed. Routine monitoring and treatment plans, and PHD-Public compliance approach (Box 11-22). The compliance approach that is applied is based on subjective socio-economic assessment of individual inspection scenario, according to KI4, where source owners can at least afford source treatment. Inspection programs are scheduled at three months intervals. Source water treatments on tri-monthly intervals are also advised. Otherwise the PHD-Source owner partnership scheme is adopted (Box 11-22).

Knowledge of the public socio-economic status and the impact of the status on safety practices are demonstrated by the PHD through the discretion devices. The PHD is able to work through socio-economic limitations of the people to achieve public compliance to safety regulations. The identified ability of the PHD indicates a positive attribute necessary to enhance the adoption of water safety plans by source owners and users. The recognised ability of the PHD also signifies the PHD as the facilitating agency for water safety developments for self supply systems in the study area.

KI_4:	*In rural areas, the people are poor but where the landlords can afford the treatment, they should be advised to do so. We can recommend to landlords to treat their water at least at reasonable intervals. Otherwise the LG can assist and help individual landlords to treat their water.* *We just treat now routinely. Anyway, there is nothing wrong in treating even the water with no problems. At intervals of every 3 months all wells should be treated.*

Source: Research key informant interviews; I: Interviewer; KI: Key informant

Box 11-22: Regulation compliance strategies based on subjective socio-economic assessments

The people problem in the second category is due to Confidence Deficiency Syndrome, CDS. As noted in the previous section, CDS is developed due to corruption notoriety of the government, which is perceived to have failed in water supply and distribution. Consequently the possibility of Government-Water user partnership is remote. The PHD is particularly faced with the consequence of CDS in the bid to broker partnership with the people. KI4 explained '…*it brings us to another problem. The government has failed to supply water to the people. Now the people have struggled to provide themselves an insanitary well. You visit as a health officer, in the first instance, the people sees you as their number one enemy. You need an approach to first calm people down to explain your presence*'. People fights against perceived government imposition (through regulations) on self owned assets. Audience is denied. Access to owned assets is also denied. As a result the PHD struggles to function in regulatory duties.

KI4 pointed out the way to reduce the impact of CDS. The respondent claimed CDS can be cured through the application of two CDS antidotes. The first antidote is calming approach and the second is enlightenment. To apply the CDS antidotes therefore, the PHD needs to develop two social relation skills; the tolerance and perseverance skills, and flair for public education. The tolerance and perseverance skill is especially important to achieve the calming effect on the people.

The category III problems relate to anti-regulatory practices of the people. KI4 identified three anti-regulatory practices namely; partial compliance, denial, and objection to regulatory exercise (Box 11-23). Partial regulatory compliance is illustrated in two instances by KI4. In the first instance, the respondent noted '*But the problem is that they will close up the well for a while till they perceive that the public health workers have shifted attention away from the area*'. The second instance occurred with sanitation programs '*Property owners erected toilets for the sake of getting the PH workers off their back but they do not use the toilet*'. The respondent thus opined '*Many of these people are very funny. They may follow the instructions of PH workers for the sake of it but may not use the resource*'.

People also express denial in the bid to avoid compliance to especially water safety regulations. KI4 noted '*In some cases they* (the people) *tell us that they do not drink from wells or that they will drink pure water*' (Box 11-23). The expressed denial corroborates the denial attitude of users to the drinking of hand dug well water (6.2.4).

Water users thus express denial to suppress regulation or to avoid being regulated. Dealing with the problem of denial is therefore important. Denial undermines safety precautions. And safety precautions are crucial to especially water safety management. To ensure public safety however, KI4 claimed '*we do advise the people on what to do....and treat the wells*'.

Source water treatment is however objected to by the people. KI4 explained '…*but the problem is that the people will not even want you to treat their water. Many objected, demanding what you want to put in the wells. We embarked on an awareness campaign before the program was successfully implemented*'. Objection to source water treatment programs thus represents the third anti-regulatory practice, which restricts regulatory duties of the PHD. To resolve the problem of public objection to regulation programs, KI4 suggest initial public support programs through awareness campaigns and enlightenment programs.

The people generated and related problems are however better resolved through people prescribed solutions. KI4 suggested '…*it is better for the people themselves to identify the problem and proffer the solutions they want by themselves. Otherwise our effort might amount to futile exercise*' (Box 11-23). Hence to stall ineffective regulatory performances, enhance visibility, and earn public partnership, the PHD should adopt the people prescribed resolutions to specified problems.

In summary, this section identifies the PHD as the institution (the best of a poor selection) to facilitate the development of water safety plans for self supply sources. The section also noted various facilitating functions of the PHD (Figure 11-1). And the overriding need to adopt user-prescribed resolutions to specified problems.

KI_4:	*I agree with you, there cannot be a safe well in Abeokuta. This again is very difficult. There are some instances in Itoku where there are no landed spaces to build toilets and you see several grave sites lined up around the properties. The public have no tap water; they can not afford boreholes, the location of the water (source) they can afford is very pathetic! In any case, we do ask some households to close up their wells if we found that the water is too poor for consumption**. But the problem is that they will close up the well for a while till they perceive that the public health workers have shifted attention away from the area.** In **some cases they tell us that they do not drink from wells or that they will drink pure water**. We do advise people on what to do for new wells. Like minimum distance to toilets or locating wells at higher elevation to toilets.* *What we used to do especially in Imeko-Afon LGA where I once served was that we go about to treat individual wells.*
I:	*What type of treatment are you referring to?*
KI_4:	*Normally we use chloride of lime for the treatment of water but the problem is that the people will not even want you to treat their water. **Many objected, demanding what you want to put in the wells.** We embarked on awareness campaign before the program was successfully implemented.* *Many of these people are also very funny. They may follow the instructions of PH workers for the sake of it but may not use the resource.*
I:	*What do you mean?*
KI_4:	*I will again refer to Imeko-Afon LGA. When the sanitation program was embarked on, so many latrines were built but the people will not use them. **Property owners erected toilets for the sake of getting the PH workers off their back but they do not use the toilet.***
I:	*Why is that?*
KI_4:	*Simply because it is a taboo in that community to squat on holes to defecate! When we visited, we saw that toilets have been built and we were satisfied that the program was successful and the people complied meanwhile the on-site or bush-site sanitation is still very much being practised. That is another problem.* *That is why it is better for the people themselves to identify the problem and proffer the solutions they want by themselves. Otherwise our effort might amount to futile exercise.*

Source: Research key informant interviews; I: Interviewer; KI: Key informant

Box 11-23: Anti-regulatory practices

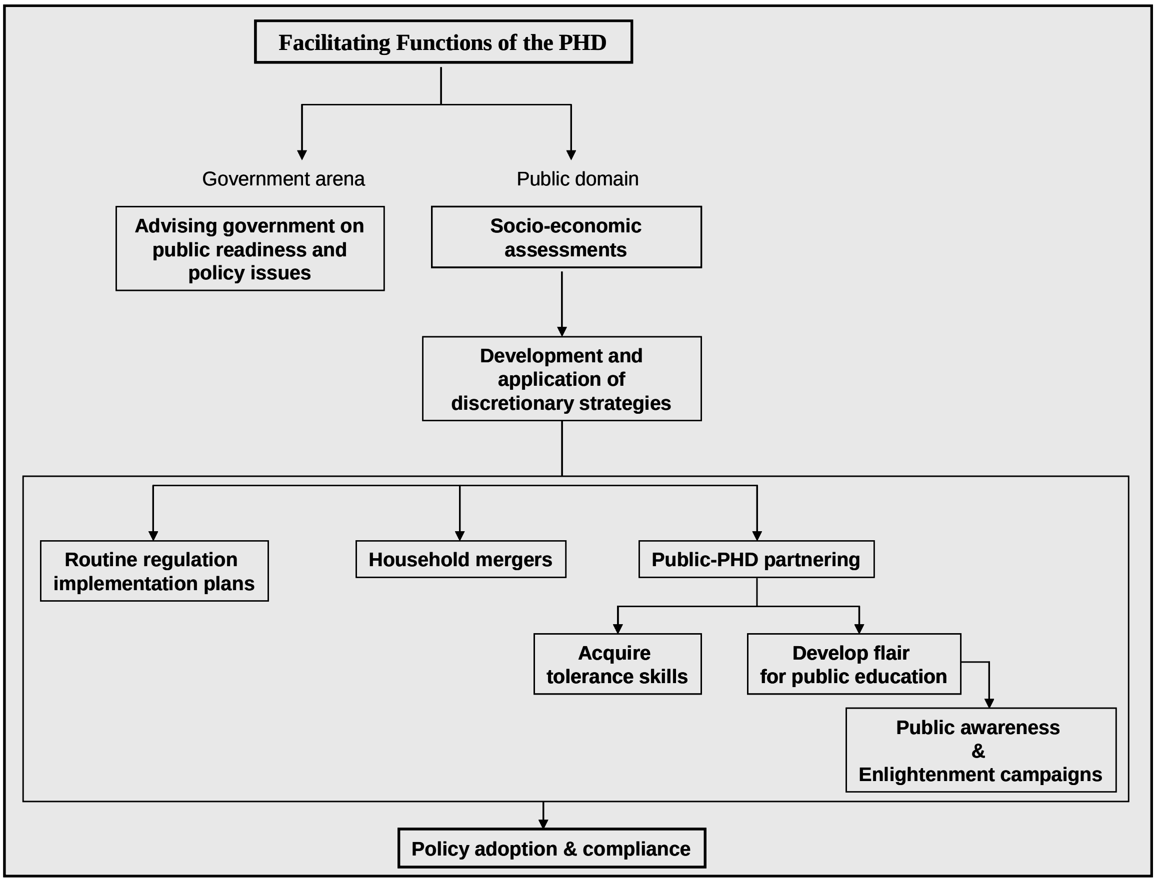


Figure 11-1: The facilitating functions of the Public Health Department

11.5 Proposed Changes to Institutional Framework

The existing water supply management institutional framework highlighted three key areas where change is inevitable for effective water supply programs (Figure 11-1). Effectiveness would be measurable by the number of people with both new and improved access to potable water supply. Such that the number of people with access to public water becomes a measurable indicator for effective governance in water supply management.

The first area of change is coordinated water supply efforts. As shown in Figure 11-1, water supply activities should be co-ordinated right from the federal government level to the local government based on a nation-wide water supply master plan.

Coordinated designated functions among the various relevant agencies should also be based on formalised region/state and local government/district water supply and distribution plans. Likewise, routing the distribution of the State agency produced public water through the local government based on agreed water supply plan should be considered.

The second area where change is inevitable is in the area of missing link or collaboration. Figure 11-1 revealed the following missing gaps:

- SON disjointed with FEPA. SON claimed to prepare another national water quality guidelines because similar document prepared by FEPA was not '*well received*' (SON, 2007). FEPA representative is equally absent in the SON water quality guidelines documentation (SON, 2007).
- Government agencies with educational institutions. Evidence of formal capacity building collaboration between the identified relevant water supply agencies and training institutions is not known.
- Water supply initiatives of local NGO are not known to align with the INGO.
- Government-LLA collaboration. The local government is advised to '*bring the LLA on board*'.

Formalised partnership between various highlighted stakeholders in the business of water supply is important. Integration and collaboration may ensure among others:

- Water for all, and
- Commitment to a single goal – safe water!

Finally for the purpose of water safety plans for self supply systems; the objects of this research, the third key area of change are proposed (Figure 11-1).

- The educational institutions should be engaged in capacity building of the following:
  - The Public Health Department
  - The LLA, and
  - Water users
- PHD should take on the coordination of water safety plans for self supply systems in association with the water users through the LLA. It should be

noted that designated RU is source owner representative in a LLA in the absence of a source owner or a source owner specified representative. It should also be advised that the PHD role in water safety plans for self supply systems be based on user-accepted regulatory measures.

PART III: CONCLUSIONS, INTEGRATED DISCUSSIONS, GUIDANCE AND RECOMMENDATIONS

12 CONCLUSIONS AND RECOMMENDATIONS

This chapter restates the research objectives, and shows how and to what extent each objective has been fulfilled. Questions are asked about the relevance, practicality, and the scope of water safety plans to self supply systems in an integrated discussion. In addition the chapter highlights the research contribution to knowledge and explores the wider context of self supply systems in the urban and/or semi-urban scenario. Finally, the chapter revisits the research limitations to present recommendations for further and better research, and ends with a concluding statement.

12.1 Research Objectives

The research set out with a broad aim to evaluate the relevance of water safety plans to self supply systems to ensure acceptable household water quality. The aim was pursued through six research objectives:

1. Assessment of self supply systems. The objective involved the assessment of types of self supply systems, the number of sources, water usage, number of users, and user perceptions of water safety and health impacts;
2. Assessment of hazards and risks associated with the identified self supply systems;
3. Assessment of the existing operation, maintenance, and management procedures of sources;
4. Identification and evaluation of existing control measures relating to self supply systems;
5. Appraisal of the development process, content and context of WHO water safety plans, and
6. Recommendation of appropriate water safety guidance for self supply systems.

12.2 Research Findings in Relation to Objectives 1 – 4

In relation to objective 1: Within the research area, self supply systems included hand dug wells and boreholes. There are 2, 280 dug wells and 38 boreholes (Figure 6-1). The principle of hand dug well technology is simple but the source design and construction features vary from protected, semi-protected to unprotected well structures. Water from self supply wells is used for both ingestion (drinking and cooking) and non-ingestion household activities. Self supply hand dug wells serve an estimated 45% of Abeokuta's population. The average number of users per hand dug well vary from as few as 20 to more than 100 users (6.1.3).

The water quality of the self supply sources is poor and not safe for consumption with faecal coliform counts at least 100 cfu per 100 ml of water higher than the WHO guidelines for drinking water (Table 7-1). The available alternative water sources in the study area are also unsafe for consumption (Table 7-2). There is therefore the need for source and household level water treatment, and the need for urgent water safety interventions for self supply wells in the study area.

The source and water safety knowledge level exhibited by self supply hand dug well users is limited both in terms of water quality status and consequence. Users are in denial of the health consequences of unsafe drinking water. There is a predominantly reactive attitude to source and water safety management. Reactive attitude underscores the need for water safety plans. Denial of the health impacts of unsafe water also denies the need for water safety interventions. Therefore an initial enlightenment and education program is crucial to address user perceptions. The need for a proactive water safety planning approach is emphasised. Understanding of water user perceptions, knowledge and attitude to source and water safety is also critical to water safety plan development.

In relation to objective 2: Hand dug well water quality is influenced by contaminant movement into wells from underground, and wellhead or surface entry. Underground contaminants entry is further impacted by land use and ownership. Size of housing plots dictate the spaces allotted to household burial sites and toilets, which represent two major sources of contamination to self supply wells. Entry of contaminants via the wellhead is determined by water user operation and hygiene. The common residential housing styles allow many and different households to co-habit a residential block and hence share the water source provided by the property owner.

Self supply hand dug wells in Abeokuta are plagued by four major water safety threats. The threats are style of source operation, construction problems, proximity to sources of contamination especially burial sites, toilets, and waste water drains, and users' hygiene practices. The four threats are critical to water safety interventions. Where water quality testing is not feasible for hazards or water safety threats identification, judgements on risk determination could be based on qualitative risk assessments.

<u>In relation to objective 3</u>: Source operation or water abstraction from self supply wells is primarily through bucket and rope. Source maintenance is principally through re-digging of well hole, repairs of well cover and well area, and source water treatment with chemicals.

Access and hygiene management are two basic source management approaches relevant to self supply hand dug wells in Abeokuta, Nigeria. Examples of the most relevant access management include access via key collection, locking of wellhead and time management. The most relevant hygiene management is cleaning of well area. The most critical challenge confronting self supply well management is the need for cooperation of resident users, and with well owners. Water providers in the context of self supply systems are source owners. Resident users are self supply source managers. The role of resident users in source management is unique to self supply sources. Recognition of this uniqueness is crucial and vital to water safety plan development for self supply systems.

<u>In relation to objective 4</u>: Source and water safety control measures require user acceptability to be sustainable in terms of adoption and compliance. The control measures with strong user acceptability include measures relating to cleaning of well

area, stipulation of minimum age limit, source hygiene management rules, and sanction of un-ruly behaviour. The other measures include display and compliance with access time, access time supervision, and stipulation of standard bucket recovery system.

12.3 Research Implications for Water Safety Plan Application – Objective 5

Existing water safety plans are generally focused on applications to public and community piped water supplies, with distinct catchment, treatment and distribution networks. The research noted the unique role of self supply systems in the bigger picture of water supply. Self supply systems differ but bridge the gap between the government public water provision and the community provided sources. The population unserved through either public water utilities or community water systems resort to self supply systems. Self supply water initiatives thus represent the third angle, which completes the water supply triangle. There is therefore the need for an urgent development of an equivalent generic water safety planning framework for self supply systems.

The management aspects of the existing WHO water safety plans are highlighted as grey areas for the development of self supply water safety plans. To appropriate existing water safety plans to self supply systems therefore, the following changes are proposed:

1. Facilitation of self supply water safety plans by an identified established relevant institution (the Public Health Department is suggested in the Nigerian context) in collaboration with source owners and the source managers – the resident users – is proposed. Self supply water providers cannot be entirely saddled with water safety plans as prescribed in the WHO water safety policy.
2. Incentives to source owners are needed for self supply water safety plan adoption. Water safety plans cannot be generally enforced in self supply systems context.
3. Stipulated safety measures must be agreed or acceptable to self supply water users because the sources are self owned.

4. A two-phase supporting program is necessary: the pre-water safety plan enlightenment programs and post-water safety plan supporting programs e.g. the role of God and man in disease prevention.
5. Adoption of a simplified 4 steps development framework comprising the system description, risk assessment, system management, and system institutional aspects.
6. Water safety plan development for self supply systems requires the involvement and collaboration of a wide stakeholder group. The relevant stakeholder groups are the government, the NGO and INGO, educational institutions, Public Health Department, the Landlords Association, source owners, designated resident users, leaders of religious groups, and medical practitioners.

12.4 Research Recommendations for Water Safety Plan Guidance – Objective 6

The research outcome generated a number of guidance steps and actions for self supply water safety plans. Guidance and implications for implementation for key stakeholders associated with water supply and safety management are presented in the research recommendations.

12.4.1 Guidance and implications for the government

The research highlighted varied government induced problems to water supply and safety management in Abeokuta, such as problem of funding and corrupt practices. To achieve the goal of safe water for all in Abeokuta and Nigeria as a whole, officials saddled with water supply responsibilities in the various government agencies need to change. Change from corruption to a more dignified commitment to assigned duties. Secondly safe water for all is hinged on the resolution of the energy sector. There is therefore an urgent need for the government to resolve the problems around energy provision in Nigeria. Thirdly there is the need for proactive actions. The government need to be proactive in infrastructure budget planning, and water agencies need to be proactive in water supply and safety management approaches.

To ensure proper water supply and safety management, the research recommends in the first instance the involvement of the local government in mainstream water provision and management. Secondly the government is advised to reinforce the role and functions of the Public Health Department in water safety management. The Department should be revitalised by channelling sufficient financial resources to procure materials and recruit adequate human resources. It is also appropriate to review public health laws in Nigeria for visible and meaningful performances of the Public Health Department. Thirdly the research recommends the production of a nationwide water supply and safety master plan. The master plan should be supported with regional or state, and local government and/or district areas water supply and safety plans.

To facilitate water safety plans for self supply sources, the government needs to provide public burial grounds for both private and public usage; create incentives like subsidies to enhance public acceptance and adoption of water safety plans; provide facilities like laboratories for water quality monitoring and surveillance; collaborate with educational institutions for training of relevant specified actors; and be involved in the design, implementation and dissemination of water safety information to users.

Due to the over-lap in mandates of government agencies, it is important for Nigerian government to address the prolific establishment of regulatory agencies, and consider the possibility of merging some of the existing regulatory agencies. As policy formulators, it is the duty of the government to define and specify regulatory functions and provide unbiased and unequivocal support to every regulatory agency. Likewise a lack of political will endangers the public and inhibits regulatory functions. Knowledge is however critical to political will and hence to public governance and safety management. It is therefore a recommendation of this research that appropriate minimum formal educational standards be stipulated for public office holders serving in any political appointment or post.

The government is advised to adopt the H model (Figure 11-2) as a tool for policy transition from formulation to adoption. The H model recognises three essential stakeholders – formulators, facilitators, and adopters - the hurdles preventing policy uptake, and the roles of the facilitators. The H model is important to adoption of water safety policies and measures in water management but also relevant to any government policy uptake.

12.4.2 Implications for the Public Health Department

The Public Health Department is advised to revisit their role in water safety regulations and management. Specifically initiate and facilitate water safety plans for self supply sources through the application of the adoption and implementation strategies, which the department is skilled in, and adopt the recommendations of water users to their (user) identified problems.

12.4.3 Implications for water users

The need for users to be vigilant to the state of water at source and point of use is vital. The need for personal health protection is also critical. Safety alertness or consciousness drives water safety actions. Water users are therefore advised to be proactive about the source and water safety management of owned sources by being safety conscious.

Similarly, problem denial does not resolve problems. Denial undermines safety precautions. Safety precautions are crucial to water safety plans. User-prescribed solutions hold the key to self supply water safety problem resolutions. Water users, especially the sources owners, should therefore overcome confidence deficiency. They should engage with the government by liaising and communicating through the Public Health Department to ensure the source and water safety of self owned systems.

12.5 Implications for Implementation – An Integrated Discussion

The author in this section queries:

1. The relevance of water safety plans in a developing urban city context, and
2. The practicality of self supply water safety plans implementation in the reviewed context.

The research outcomes show self supply system practices in a growing urban city in a developing country where poverty, ignorance, denial, and institutional failures among others, are characteristic features. The research findings suggest the need to query the application of the current format of water safety plans in the presented context.

Evidence from the research emphasises the need to safeguard water quality of self supply sources and arguably the relevance of water safety plans to water sources in the described context. Research outcomes show that first, appropriate targeted programs of enlightenment are required to aid user understanding of water quality issues and links to ill health. The WHO ten steps water safety plan framework is however not suited to the context of urban self supply systems. A few of the identified constraints are discussed in the following text.

Reason (1997 and 2000) provided a classic analysis of the means of managing risks of organisational accidents. The author introduced the Swiss cheese model for describing failures where there may be multiple defences provided to prevent failure. Basically the Swiss cheese model has four components; the initiating event, the latent conditions, the active flaws, and incidence occurrence (Figure 2-2).

By depicting self supply wells as a unit system, risk management of the whole system can be described with the Swiss cheese model (Table 12-1). To fit the model, a few of the identified peculiarities and management constraints of self supply wells are classified as latent conditions and active flaws that are typically responsible for the system failure. The classified latent conditions and active flaws also represent some of the major hindrances, which need to be resolved to achieve self supply water safety planning. On the other hand, and in the event that water safety plans for self supply systems are adopted and implemented, resolution of the hindrances could signify the multiple defences to prevent failure. The key failure factors are discussed below.

Table 12-1: The Swiss cheese failure mode of self supply hand dug wells

Initiating event: Poor well construction (unprotected and semi-protected wells)

	Latent conditions	**Active flaws**
Technical factors	Uncovered wells	Ingress of waste water into wells
	Pump not installed	Usage of un-kept and multiple buckets
	Proximity of wells to sources of contamination	Percolation of organic matters, chemicals, and faecal bacteria
	Low-level wellhead	Ingress of storm water into wells
People problems	User's ignorance of link between unsafe water and health impact	Unhygienic activities around wells
	User's denial of health impact	User's reactive responses to source and water safety
	Ownership influence on system management	Undefined access supervision and control
	User's believed it is the role of God to prevent diseases and sustains good health	User's shift the role – water safety plans - of man in disease prevention
Institutional factors	Corruption practices in public water supply and management	User's confidence deficiency syndrome
	Institutional capacity weaknesses of the Public Health Department	Unregulated self supply systems

Incident occurrence: Poor water quality

Proposed failure recovery

12.5.1 Technical factors

Major technical irregularities with self supply hand dug wells include construction and well operation problems, and proximity of wells to sources of contamination. The highlighted technical issues represent three out of the four identified water safety threats to self supply systems. The fourth is the problem of hygiene behaviour.

Technical factors can be corrected through appropriate active regulation. Regulation would require prescription of safe-proof standards, adequate dissemination of the set standards, and backed with sufficient enforcement strategies. Appropriate regulation would include stipulation of a wide range of design and construction standards, varying from best practice (e.g. precast ring lining) to safe practice (e.g. cemented block lining); stipulation of minimum safe distance of wells to household assets like toilets; and encourage the usage of dedicated bucket and rope.

Appropriate regulation would only be effective if necessary prerequisites were in place. For example, provision of subsidies to self supply system owners is important to create incentives for compliance with approved well construction designs. Provision of public burial grounds for both private and public usage is also essential.

12.5.2 System ownership

System ownership is crucial and unique to self supply systems relative to both public and community water supply systems. System ownership in self supply wells can mar systems' failure. Where the source owner is both resident and active in system's access, operation and hygiene supervision, system ownership serves as a defence to prevent system's failure. In the absence of the source owner, owner representatives or a designated resident user to manage the affairs of the water source, system ownership can become a major constraint to source and water safety of self supply wells. Implementation of water safety planning would therefore do well to recognise system ownership complexities and the important role it occupies in self supply systems management. Involvement of source owner, owner representatives and/or a designated resident user is therefore vital in water safety development for self supply systems.

12.5.3 Denial syndrome

The predominant attitude of users to health impact is denial. Denial is driven largely by ignorance and religious belief. Many users do not make the link between water borne diseases, their causes, and route of transmission. Religious belief clouds the role of man in disease prevention. Ignorance and religious beliefs, which influence denial, thus represent a crucial hurdle in water safety plan implementation. Missing the link between the cause, and the effect or shifting the responsibility of disease prevention undermines the need for water safety plans. The 'cure' for ignorance is knowledge. Enlightenment and appropriate training clears obscured perceptions and orientation. If appropriated, informed knowledge through targeted enlightenment, training and awareness campaigns could overturn denial and serve as an effective failure defence mechanism in self supply water safety planning. Appropriate training would also stimulate vigilance of source, water and health safety. The necessary target training would include among others the role of God and man in disease prevention, and water borne/related diseases.

12.5.4 Reactive culture

Reactive culture in the context of this discussion is a people problem as well as an institutional factor. Jaeger and Kanungo (1990) established that reactive culture is a common characteristic of developing countries. People (water users) are generally reactive in their response to health and water safety. The institutions are also usually reactive in management and planning. The winning principle of water safety plans is however taking proactive actions at any level (people or institutional) to minimise or prevent water safety threats.

For the purpose of water safety plans implementation, a proactive risk management culture would need to be embraced. The first requirement in generating a risk management culture is to create a reporting culture. A prerequisite to a reporting culture is the capacity to manage knowledge (IOSH, 2004). Knowledge on the other hand can only be managed if known or made available to relevant stakeholders.

This research shows that reactive culture is influenced by varied knowledge levels and in some cases ignorance. The steps to proactive response and management culture would therefore start with awareness campaigns, enlightenment and target trainings to relevant key stakeholders. When the necessary actors are informed and capacitated with the right knowledge (capacity building), then knowledge management can ensue, reporting systems come on board, and risk management culture facilitated. Until then, it might be a long wait for water safety development and implementation.

12.5.5 Institutional factors – corruption in high places

The impact of corrupt practices in government circles as highlighted in this research is an active flaw that could always ground any system to a halt. Corruption within the water sector leads to limited water supply. The effect of corruption on water users is loss of confidence in government or institutional initiatives. Loss of confidence in turn endangers the application of water safety plans.

In the context of self supply systems in the research area, water safety plans require respectively adoption, development, and implementation. Water safety policy is ineffective and technically useless without adoption. Where corruption in policy-making circles thrives, a wedge is constantly drawn between policy and its adoption. The adopters' lack of confidence in policy formulators, and invariably in the policy making processes results in little or no adoption. Failure in the adoption of consumer pre-paid meter for electricity power supply in Nigeria is typical.

The author therefore fears for water safety plans adoption, development and implementation if corruption in government spheres is not phased out and replaced rather with commitment to public duties.

12.5.6 Institutional factors

The water providers in question (self supply source owners) are not competent to either initiate or develop water safety plans of their sources without tailored guidance. Hence the need for an established institution to facilitate the development of self supply water safety plans. The suggested institution – the Public Health Department – has the mandate, potential skills, and expertise to function in the proposed capacity. However, the institutional structure and facilities of the department, as is currently the case, is unsuitable and therefore the department may not be competent to coordinate the development of self supply water safety plans. Recognition of the institutional weaknesses signifies a dilemma as the development of self supply water safety plans in the reviewed context may be a mirage. The urgency attached to the need for self supply water safety plans may not be attempted until the various requirements to revitalise the Public Health Department are in place or until another suitable institution/agency is identified or created. Whichever route is followed, the development and implementation of self supply water safety plans would be delayed and the delay would remain until the institutional aspect of self supply water safety plans is addressed.

In summary, the researcher proposes a water safety recovery route from the institutional factors through the people problems to the technical issues of self supply systems as shown in Table 12-1. The key to the people problem is enlightenment and training. The answer to the technical factors lies in user participatory regulations.

Given the need for self supply water safety plans and the possibility of eventual development and implementation, a summary guidance to how self supply water safety plans can be achieved by identified key stakeholders is set out in the research recommendations (12.4).

12.6 Implications for Self Supply Systems – Wider Context

The study area, Abeokuta is a developing urban city. The water supply situation in Abeokuta as described in the research is typical for many towns and cities in especially the south west region of Nigeria. As estimated in the research, about half the population are not served with treated public water systems. Extension of the public water distribution network is not commensurate with the rate of population growth and city expansion. The unserved thus rely on self supply water initiatives for their water needs. As such, self supply water initiatives feature among the unserved in the urban and semi-urban areas, and are consequently not restricted to rural areas. Upgrading self supply sources in mainstream water supply management is therefore necessary. And ensuring the source and water safety of self supply sources through appropriate water safety plans is critical and urgent.

The concept of self supply systems is known, common and widely practised throughout the world. Many of the figures presented for self supply systems in the Sub-Saharan Africa are however from the rural population, implying that the figures exclude data from the unserved urban and the semi-urban regions. Findings from this research show that self supply systems represent a coping strategy for the unserved in cities as well as rural areas.

In the push for self supply systems to be recognized as important household water services, the focus has generally been limited to issues of access, quantity, affordability (cost) and simple technology. Evidence of the water quality status of self supply wells shown in this research suggests that there is the need to include and target water quality in the general consideration of self supply systems. The need for water quality inclusion is both critical and urgent.

12.7 Obstacles and Opportunities

In this section the author takes a step back to review the research from a wide perspective and to suggest possible alternative routes to achieving water safety in self supply systems. Two issues are discussed; the limitations of the knowledge-deficit model presented (12.7.1) and the likelihood of institutional change (12.7.2). A summary highlighting the possible way forward is presented in 12.7.3.

12.7.1 The knowledge-deficit model

This sub-section aim to answer the following questions:

- Is it really only a lack of knowledge which holds people back from engaging with water safety?
- If not, what other issues are involved?

- Why might people rationally choose to focus on having water near home (via self supply) but worry less about water quality?
- How might research explore these issues further in future?

These questions are discussed below.

The research found that people do not look after water safety at least in part because for them poor water quality is not generally associated with health risks. Limited knowledge is also evident concerning what could be done to remedy the situation. Hence limited knowledge or ignorance contributes to inaction. This finding, which highlighted the link between knowledge (or rather lack of it) and water safety, may be described as a knowledge-deficit model of behaviour.

It should be noted that a knowledge deficit is often one of the findings of studies of knowledge, attitudes and practices. Studies which investigated the knowledge, attitudes and practices of, for instance, pregnant women to malaria in Nigeria revealed that most (61%) of the pregnant women studied displayed ignorance about malaria prevention (Idowu and Mafiana, 2007). Schultz et al. (1994) also found that a significant number of women in their study of Malaria and childbearing women in Malawi demonstrated poor knowledge of the effect of malaria on pregnancy. As a result of such findings, the first set of recommendations includes awareness campaigns and education of the target groups.

However, a closer examination of the evidence provided by this research revealed that there may be wider reasons beyond knowledge-deficit, which account for peoples' choices around water safety and health. For instance, in the event that there are available alternative water supplies, savings in time, energy and money to pursue other important livelihood issues like provision of food may be considered as the opportunity cost over investment (time, energy and money) in water safety measures for self supply systems. It should be recalled that alternative water sources are (arguably) perceived to be better in terms of quality. Statements like '*I'll rather pour the water away than treat or use alum…*' (R95; 10.1.9) and non-drinking of well water due to the thought of having to first boil the water before consumption (Table 6-

5; 6.2.1) suggests that the needed water safety measures/actions are too money, time and energy consuming to be worth pursuing in the face of other pressing household needs. Savings on investments (time, energy and money) in water quality and safety to pursue other household priorities may perhaps thus make source owners and users to worry less about water quality after having gone through the trouble to resolve the problem of water quantity and accessibility by providing self supply systems. In other words, water quality may take second place to proximity, quantity and accessibility.

The possibility that people resist engaging with water safety and health due to factors beyond knowledge-deficit is not unfounded. Some examples are cited here. Curtis (2001) found that factors like nurture (a desire to care for children), the wish to gain status and social standing, and to be clean and neat in order to avoid objects and smells that elicit disgust are factors found to drive motivation for hand washing rather than the knowledge of the link between hand washing and health. Similarly, Idowu and Mafiana (2007) found that peer group influence, prevention of human-mosquito contact[45], and detest for the noise-making attribute of mosquitoes are reasons for the uptake of measures to prevent vector contact rather than the knowledge that the vector transmits disease. In the words of Curtis (2001) therefore, '*People are not wholly rational beings who act according to a rational calculation of risk, rather what people do is led by multiple considerations, which are at the same time innate, environmentally driven and learnt*'.

Curtis surmised that health is not the only motivation for hygiene behavior; other goals may be far more important (Curtis, 2001). In another context the same author argued that promotion of hygiene behavior through teaching about germs (knowledge-based approach) was ineffective and insufficient (Curtis, 2003). Curtis's argument and summation are relevant to the issue of water safety plans for self supply systems. While not underestimating the role of knowledge-based interventions (education and awareness campaigns), which is borne out of the knowledge-deficit model, the way forward in the adoption of water safety measures amidst self supply users may be

[45] Prevention of human-mosquito contact is borne out of the fact that mosquitoes suck human blood and not because the vector transmit infections.

rooted in the identification of factors which drives user motivation rather than in solely knowledge-based approaches. Identification of the actual opportunity costs of water safety measures may thus present a more appropriate route to water safety plans adoption and implementation among water users. Research into the opportunity costs of water safety measures is therefore worth pursuing.

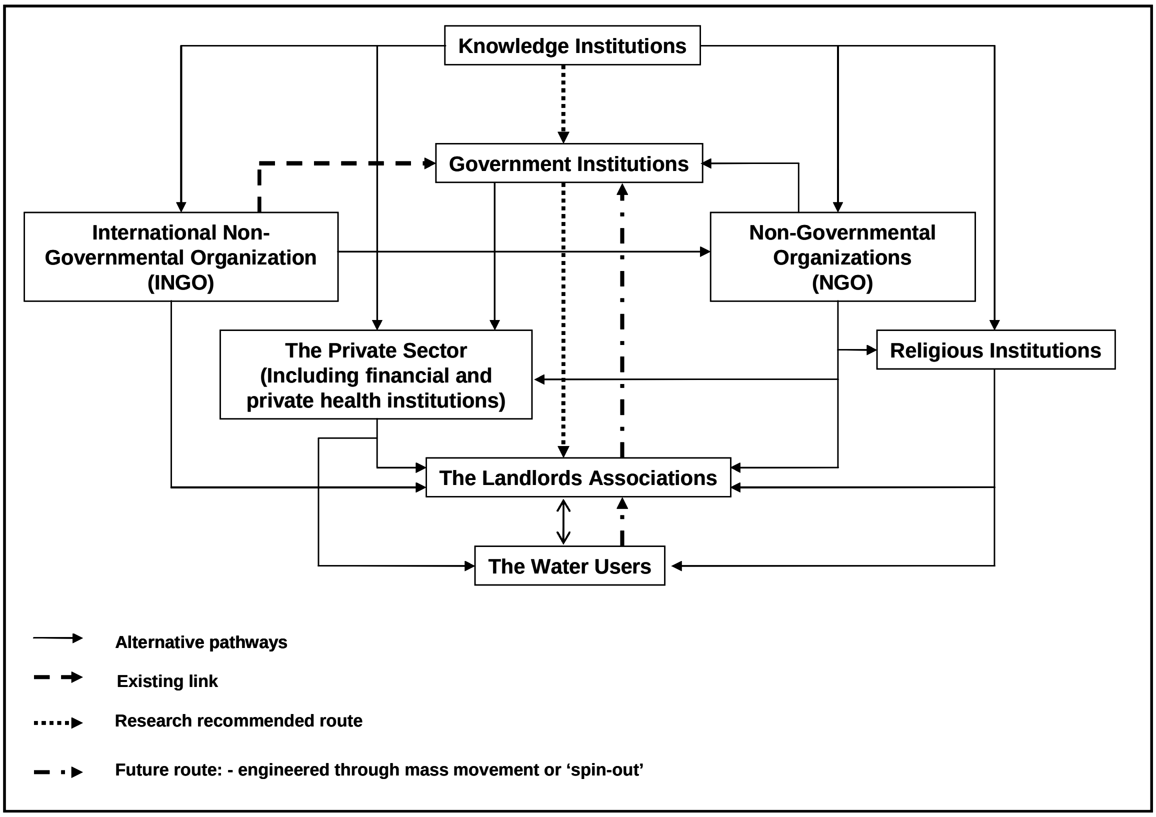
12.7.2 Likelihood of institutional change

The author in 12.5.5 expressed concern for the self supply water safety plans (SSWSP) development and implementation in the face of existing institutional problems and weaknesses. The main fear is the possibility that the various research recommendations may not be acted on or implemented, at least not in the short term. Admission of the likelihood that water safety planning for self supply systems may not happen due to uncertainty in institutional changes raised the following questions:

- Does that mean that water safety planning for self supply systems is effectively dead?
- Or can a certain amount be done by source owners, households or neighbouring groups at least to achieve partial water safety?
- Given that any such options would require more involvement of households, how could they be motivated or incentivised to look after their own water safety?

Water safety planning for self supply systems is viable. The research shows evidence of existing water safety measures and source management practices (9.2), which are sustainable (already in practice) and could be built upon. What is however missing is widespread adoption and systematic water safety planning amidst water users, a feat which can be achieved faster and better with external institutional support.

However, taking a cue from the theory of technology transfer, there are usually diverse pathways to move a technology or practice from the innovators/developers to the recipients/end users (UNEP, 2003). In the absence of currently feasible institutional (government) support and facilitations, the research identified other key stakeholders who could play the role of change agents in self supply water safety planning and adoption (Figure 12-1). The role and suggested functions of the key stakeholders are discussed further.



Adapted from UNEP (2003)

Figure 12-1: Some key players in the development transfer of self supply water safety plans (SSWSP), illustrating the diversity of pathways

Knowledge institutions

Presently, the knowledge and blue print of self supply water safety framework resides with the knowledge institution notably, the researchers, the educational institutions and relevant professionals in the field of water safety management. The knowledge institutions thus represent the innovator or technology developer or supplier in this respect. Dissemination of research outcomes could be tailored to deliberately target the other identified stakeholders in self supply water safety development and implementation. Examples of the stakeholders are the NGO, INGO, religious institutions and the private sector. Collaboration with the other identified key stakeholders could also be engineered by the knowledge institutions for the purpose of water safety plans development and implementation. The need for broader research opportunities and projects may perhaps drive such collaboration.

Private institutions

The relevant private institutions would include manufacturers of household water safety and treatment solutions e.g. Water Guard manufacturers. Social marketing strategies exploring both the knowledge and socio-economic route to motivate product/practice uptake is advised. As earlier noted the knowledge-based route is insufficient in itself. Stimulating water user motivation through other factors (like opportunity cost, and emotions – e. g. disgust or detest as in the case of hand washing and malaria) coupled with education and awareness (product/practice advertisement) campaigns would be a more effective means to water safety measure adoption by the end (water) users. The need for corporate responsibility, socially accepted product brand plus (hopefully) increased economic gains may drive the involvement of the private sector.

INGO and NGO

Promoters of water safety plans at both the international and national levels are key stakeholders. Notable promoters of water safety plans at the international level are the WHO, UNICEF, Water Aid and the World Bank to mention a few. These organizations are often represented at the national level. The research in 11.1.2 showed evidence of existing collaboration between UNICEF and the national government at the state level. UNICEF is active in water supply (provision of boreholes) and environmental health (guinea worm eradication). The need to achieve the targets of the MDG is one of the incentives that drive the INGOs.

The collaborative role of the INGOs at the national level could however be broadened beyond the current government-INGO pact to include networking with the knowledge institutions, the relevant indigenous or local NGOs and the LLA. The extended partnering links would create new and multiple routes to reaching the target end users in the promotion of water safety plans.

Indigenous NGOs could also facilitate the promotion of water safety plans via the religious institutions.

Religious institutions

The influence of religious beliefs on water safety plan development and implementation is noted in this research. Water users were found to ward off sicknesses with statements like '*God forbid…*' or '*God will not allow such (cholera) to happen in our area…*', which represent expression of faith in the Supreme Being who is considered able to prevent diseases. The identified impact thus place important task on religious institutions. Water safety plans promotion routed through religious teachings and activities may encourage a widespread adoption of water safety measures among water users. The onus however lies on the knowledge institutions to collaborate with religious institutions in the dissemination of informed knowledge.

The LLA and users

The land lord associations, invariably the source owners, and the self supply users are the end users or recipients of water safety plans. Source owners who already practice some form of water safety measures could play a role of change agent and promoters within this category of stakeholders. Such source owners could influence fellow source owners to adopt and uphold source and water safety of their systems. Collaboration of INGOs, NGOs, knowledge and religious institutions with source owners serving as change agents would incentivise the source owners and also encourage (or rather stimulate) other source owners to adopt and implement water safety plans. Collaboration with source owners may be in the form of capacity building (water safety plan development training), and provision of subsidies for source improvement and/or water treatment solutions. It is expected that collaboration with the end users outside the government-INGO pact would, among others things, by-pass the influence of corruption in the process of water safety plans adoption and implementation.

In summary the institutional problems which create a poor enabling environment for the direct development and implementation of SSWSP could be by-passed by the repositioning of roles and functions of relevant identified key stakeholders. The importance of collaboration between the key stakeholders is also emphasised. It is also expected that hopefully and over time, the (governmental) institutional changes in relation to SSWSP development and implementation would perhaps be driven by 'spin-out' or grass roots movement from the water users (Figure 12-1).

12.7.3 The way forward

Identification of knowledge gaps is noted as the primary starting point in the process of development. The limiting role of the knowledge-deficit model and the knowledge-based intervention approaches which the model informed is however recognised. It is therefore important to investigate the factors or rationales beyond knowledge-deficit that informed peoples' choices where safety issues are involved. That is the opportunity costs that make source owners and users worry less about the water quality and safety of their systems. Routing adoption strategies through an alternative set of incentives may represent a more robust approach to SSWSP adoption and development among the target group.

Water safety planning for self supply systems is feasible. The existing (government) institutional incapacitation may be circumvented by repositioning the roles and functions of relevant identified key stakeholders. Existing links could be built upon, and new links created to expand the networks needed for the facilitation and promotion of water safety plans. Engaging with the end users through identified key stakeholders order than the government and through the expanded stakeholder networks may result in a widespread adoption of water safety plans.

12.8 Research Contributions

The research has been able to study in depth self supply hand dug wells. Research findings reveal various peculiarities of self supply hand dug wells, which distinguish these sources from either the government owned or community owned water systems. The research highlighted, in the first instance, the need to ensure source and water safety of self supply sources. Secondly, the research showed the need to redefine water safety plans to make the plans relevant to self supply sources. Thirdly, the research recommends how development of water safety plans could be appropriated to self supply systems. The research is the first to evaluate urban self supply systems with a view to designing water safety plans. The outcome of the research is a useful resource for advocacy of water safety plans for small urban water systems. The research findings are a useful source of information on self supply systems practices in Abeokuta, and Nigeria, and a resource for self supply water safety guidance in Nigeria.

The H model (11.4.5) policy adoption concept is credited to the research. The research moderated sanitary inspection forms to design forms suited to the needs of self supply systems. The research revealed the existence of a possible relationship between sanitary inspection scores and microbial contaminations of water sources. With further research, the relationship may prove a useful tool in drinking water quality modelling.

12.9 Research Limitations – Recommendations for Better Research

A major limitation in the research centred on the microbial water quality testing. The number of hand dug wells to be tested within the time frame and the lack of relevant field testing kit meant that it was not possible to be carried out by the researcher in the field. Consequently, the samples were analysed by a local laboratory. Resorting to laboratory microbial water quality testing in a developing country raised the question of data reliability. To enhance field data quality in specific hazards identification therefore, the research recommends the development of innovative, and user friendly potable meter for in-situ microbial water quality measurements. Subject to research, specific microbial contaminant meters e.g. TTC meters are desirable for microbial assessments in any water source of any technology type especially self supply systems and in particular for developing country scenarios.

It is nonetheless important to note that research in the development of the recommended microbial or faecal contamination meter is on-going. The project facilitators – AQUATEST consortium - are currently seeking early adopters for the initial 9 months field testing scheduled to commence in January 2011. The project is scheduled for completion by the end of the year 2011. Further information of the research progress can be found on http://www.aquaya.org/impact_aquatest.php.

Secondly experiences during the research interviews show that structured formal or semi-formal interviews styles produced usually closed ended responses. Engaging respondents in structured but informal conversational discussions on the research matter however yielded rich and analyzable (essentially descriptive) response contents. For better research outcomes therefore, especially in similar research scenario, structured but informal conversational interview approach should be adopted.

12.10 Recommendations for Further Research

Benefits of the water safety plans approach to ensuring safe water and water quality management are commonly claimed (Breach and Williams, 2006; Gregor, 2007). The various benefits were derived mostly from focusing on the water safety plans applications to public and community piped water supplies. This research noted the limitation of water safety plans to self supply hand dug wells. Further research is needed to first test the various self supply water safety guidance provided in this research to investigate the suitability to self supply hand dug wells. Action research is however recommended. Action research would provide room for concurrent reflection and development of guidance. On-going reflection would allow iterations to refine and better adapt developed plans to self supply systems needs. Further research is needed to highlight limitations (if any) of existing water safety plans to other self supply systems. This aspect is important to promote the development of water safety plans suited to the needs of different types of self supply systems, and to highlight the (presumed) benefits of water safety plans to self supply systems.

The concept of self supply systems is known, common and widely practised throughout the world (Sutton, 2004a). Similarities and differences in practices and scope of self supply systems in various regions of the world or at best between the developed and developing country context is however not yet reviewed. A review of self supply systems characteristics is therefore recommended to facilitate the development of self supply water safety plans, which could serve as a generic guide or framework for self supply systems. The development of generic self supply water safety plans may hopefully increase the progress of water safety plans development and application in especially the developing regions of the world where application of water safety plans is currently quite slow.

The assessment criteria in many of the available examples of standard sanitary inspection forms are scored on a two-way ‘yes or no’ answer (Davison et al., 2005). The possibility of variations between criteria and the observed are not provided for within the two-way answer system. Aside the subjectivity involved in sanitary survey, the ‘yes or no’ scoring system assumes a rigid dogma between the assessment criteria and the observed sanitary faults, and hence may not always represent the correct sanitary problem. The sanitary survey experiences during the research encountered the highlighted problem. To avoid a sanitary inspection scoring system that either exaggerates or underplays particular risk scores, the research recommends the use of the proposed 1 – 5 scoring systems with specified scoring criteria for sanitary survey forms. Subject to further research, the development of standardised system specific sanitary forms is also recommended.

The research for the second time finds a probable relationship - maximum expectable contamination index (nitrates) concentrations for a certain sanitary score - between sanitary inspection scores and contamination index. Recurrence of probable relations between sanitary scores and microbial contaminations indicated by nitrate concentrations or TTC is worth further investigation. The relationship may prove a useful development in drinking water quality modelling.

The possibility of the influence of the level of formal education on hygiene behaviour of users is suggested in this research. The influence of the socio-economic status of water users on hygiene behaviour was however not within the scope of this research. A study into the possible impact of socio-economic indices on hygiene behaviour and implicitly on source management is therefore advised.

Finally, the implementation of any priority risk management action would require the consideration of cost. The cost implication of water safety plans was not within the scope of this research. The opportunity costs to the uptake of water safety plans among users were also not investigated. Further research is therefore advised to address the cost (monetary or otherwise) of self supply systems water safety plans adoption, development and implementation.

12.11 Closing Statement

Self supply systems have been shown through this research to be water supplies initiated through self help by the unserved urban, semi-urban and rural populations. Self supply systems serve to bridge the gap between the government public water provision and the community provided sources. Self supply water initiatives complete the water supply triangle. The population of people exposed to self supply sources is considerable, but the water quality of the named sources is generally questionable. To achieve safe water for all therefore, there is an urgent need to ensure source and water safety of self supply sources through ***'appropriate water safety plans'***.

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ANNEX 1: Cluster Descriptions and Selection Processes

Table A1: Self supply location index (clusters); index description, descriptive features, and potential water safety problems.

	Location index	Description	Features/ characteristics	Potential water safety problems
1	GRA	These are Government Reserved or Residential Areas (GRA). They are allocated to civil servants on active service. The government provides water through public water works and occupants are not allowed to own any water asset in the GRA. Public water supply is irregular, but occupants store water into 250 – 500 gallons plastic or GI surface tanks to bridge the gap between flows. The research did not consider this category. In recent times however, the non-built part of the GRA are sold to wealthy individuals to build private properties. Self supply boreholes with usually in-house water connection pipe networks may be common within this category. The research inventory included this category.	Planned built area.	Source protection is good, but household water handling may be a concern.
2	Low-cost housing estates	Low-cost housing estates are built as part of government effort to make housing more accessible to the populace. Housing units of usually 2 and 3 rooms' apartments per plot are built in large numbers and sold at 'affordable' prices to interested buyers. Each apartment is supplied with public water connection point. Once sold, the owners are free to use the apartment and remaining non-built part of their plot as they deem fit. Individual new owners then usually construct a hand dug well or borehole depending on their financial ability to argument water from public water points.	Planned built area.	
3	Newly developed areas	These are recent city expansions. Cheaper (relative to the built up city areas) lands are available for sale at city outskirts. Cheaper land rates consequently lead to expansion of the city as housing developments are shifting outwards. The new areas are usually less dense relative to the city centres. Property owners are responsible for water provision on their properties. Hand-dug wells as self supply is usually very common in these areas.	Absence of town planning. Haphazard built area, usually mix of fenced and unfenced houses in ratio 3:1. Houses are better spaced relative to the down town part of the city.	
4	Densely populated areas	The city core referred to as down town areas are densely populated. A peculiar feature is complete absence of town planning or layout. Houses were built haphazardly with generally no fencing or demarcation between	Clustered and generally unfenced housing units. There is generally lack of	Water sources come under heavy influence of poor sanitation practices: - on site and leaks from

		separately owned properties. Also, there are usually no spaces between houses that in some cases, 2-4 houses may be sharing the same backyards. Sanitation practices are poor and hygiene levels are assumed low as well. Hand-dug wells are common self supply, but are used by both owners and non-owners.	drainage networks and waste water from individual houses flow un-channelled.	latrines. Animal invasion, un-channelled domestic waste water and human organic waste from house area grave sites. Water handling at the household is influenced by poor hygiene practices.
5	Sparsely populated areas	The main difference between Newly developed area and sparsely populated ones is that the latter are found within the town and not at the outskirts / city extensions. They are sparsely populated because the areas house public institutions like schools, government offices and/or hospitals. The features are however also generally similar to Newly developed areas except where hospitals are found.		
6	Commercial	The commercial areas are mix of office complexes, trading centres' and residential houses.	Locations are planned to moderately planned	
7	Market areas	Market areas are where big markets /and shopping malls are located and such co-exist with residences, which have features generally similar to densely populated clusters.	It is generally an open market scenario.	Water source may come under the influence of leachate from solid waste dumps, animal invasion and sanitation practices around large public markets.
8	Cottage industrial areas	Cottage industry is one in which employees work in their homes, often using their own equipment. This description largely fits the textile dyeing industry in some part of the study area. Families from Itoku part of Abeokuta pass the art and trade from one generation to the other through their lineage. The industry is localized and is between small to medium scale. Small, because it is controlled at individual family levels. On the whole however, the industry can be termed medium scale. Families could employ more hands depending on the magnitude of fabric to process. Over the years as well, due to large increase in demand, the level of interest in the art has grown, leading to a concurrent growth in the number of apprentices that almost every household in Itoku is involved in the textile work or sales. The presence of hand-dug wells is substantial in the locality and the area has similar features with the densely populated areas (DPA) plus additional features relating to the effluents from textile dyeing. The industry has existed for decades in the particular location and could have significant influence on the ground water resources. It should be noted that most textile waste waters contain dyes, heavy metals and/or organic contaminants – such as chromium, copper, molybdenum, zinc, total		Water source contamination from cottage industrial activities (e.g. dye), sanitation practices and animal invasion may be expected.

		organic carbon (TOC) and total dissolved solids (TDS) (Reife, A. & Freeman, H. S., 1996).	
9	Industrial areas	Industrial areas are located particularly within, but just outside the built area of Abeokuta city. The industries include: paint factories, aluminium plants and a number of agro-chemical industries. Effluents from these plants are emptied into nearby stream and as such effects on self supply may be minimal since residences are scarce around the area.	
10	Areas around major hospitals	There are 4 major hospitals within Abeokuta city. Two are located right within the densely populated areas, one around the commercial centre while the fourth is within the sparsely populated area. Discharge of waste water from hospitals into surrounding drains is a major concern in this research.	
11	Auto mechanic villages	In time past, auto mechanic workshops are located on any available un-built plot within the built area. In recent times however, a government policy moved and restricted auto mechanics workshops to four locations at the borders of the city and are called Mechanic villages. There are however still some workshops within the city centre. Hand-dug wells are found scattered within the auto-villages.	Water safety problems may be due to constant pollution from oil, gas and petroleum products.

Cluster-based approach**:** '*Water supplies within different regions are clustered together to reduce costs of making verification and sampling visits whilst yielding valuable information*' (Howard, 2003).

<u>Summary of cluster features or characteristics (descriptive):</u>

1. Population density
   - Low
   - Moderate, and
   - High
2. Town planning/layout
   - Planned
   - Unplanned
3. Land use
   - Residential
   - Commercial/markets
   - Institutional (hospitals/burial grounds, schools, government secretariats)
   - Industrial (cottage industries- textile dyeing; large industries – agro-chemicals, paint, etc.)
4. Human activities
   - Timber factories
   - Building blocks manufacturing
   - Abattoirs
   - Auto-mechanic
5. Multiple or overlapping features

Table A2: Priority cluster selection matrix: Approximate location of eleven (Table 1a) isolated clusters in Abeokuta, Nigeria

Population density & Degree of town planning					
5	Clusters 1 and 2			
4	Cluster 3		Cluster 5	Cluster 9 and 11
3		Cluster 6		
2				
1	Cluster 4	Cluster 7	Cluster 10	Cluster 8
	Residential	Commercial/market	Institutional/Hospitals	Industrial
	1	**2**	**3**	**4**

Land Use

Assumption for cluster selection: Population density, degree of town planning, and land use influences water quality of self supply systems

Key: Population density & degree of town planning, 5: Planned low population density areas; 4: Unplanned low population density townships; 3: Moderately planned to moderate population density; 2: Planned high population density areas; 1: Unplanned high population density townships

Colour code: Red: critical or priority clusters for water safety; Blue: 'Experimental' control cluster; NB: Clusters 3, 4, 7, 8, and 10 are the five selected clusters

Summary features of the 5 selected clusters: Group 1 (Cluster 4): Residential/high population; Group 2 (Cluster 7): Commercial/high population; Group 3 (Cluster 10): Institutional/high population; Group 4 (Cluster 8): Industrial/high population; Group 5 (Cluster 3): Residential/low population density; NB: The 5 selected clusters are all within the unplanned city areas.

Table A3: The number of wells visited within the representative townships of the selected 5 clusters, groups 1 – 5 (First field study; April 2007)

Research cluster Groups	Townships	Number of wells	Total wells per group
1	Amolaso	5	
	Grammar/Itori-Odo	3	
	Ijemo	5	
	Adedotun	2	
	Oke-Aregba	5	
	Abiola way (Ijeun-titun)	5	25
2	Omida	5	10
	Lafenwa	5	
3	Lantoro	2	
	Sokenu	5	7
4	Itoku Area	9	9
5	Obantoko: Fajol to Somorin	12	32
	Adigbe: Saraki to Idi-mango	10	
	Kemta	5	
	Ita-Elega	4	
			82

ANNEX 2: Well Selection Processes

Table A4: 25 observation wells: Criteria (sanitary scores, microbial data, accessibility, group representation) for selection

SN	Sample Nos.	TC/100ml of water	E Coli Present/Absent	C. Perfringens Present/Absent	SI 1 Scores	SI 1 Risk classes	SI 2 Scores	SI 2 Risk classes	Selection	Selection criteria
1	AMLS 1	3,500	P		56	M	26	M	S	Presence of E.coli; Accessibility
2	AMLS 2	17,000	P		41	H	24	H	S	H risk class; Presence of E.coli
3	**AMLS 3**	35,000	P		56	M	26	M		
4	**AMLS 4**	11,000	P		70	L	26	M		
5	**AMLS 5**	55,000	P		50	H	18	H		
6	**AMLS 6**	14,000	P		38	H	16	VH		
7	**AMLS 7**	17,000	P		37	H	19	H	S	H risk class; Presence of E.coli; accessibility
8	**AMLS 8**	160,000	P		39	H	17	H		
9	**IJM 1**	55,000	P		30	VH	15	VH	S	VH risk class; Presence of E.coli
10	**IJM 2**	160,000	A		28	VH	17	H	S	VH - H risk class; High TC
11	**IJM 3**	55,000	P	P	51	H	27	M	S	Presence of Clostridium
12	**IJM 4**	160,000	A		24	VH	22	M		
13	**IJM 5**	160,000	P		66	M	31	L	S	Presence of E.coli; accessibility
14	**ADT 1**	1,100	A		54	M	28	M		

15	**ADT 2**	160,000	P	49	H	23	H		
16	**ABW 1**	90,000	P	65	M	33	L		
17	**ABW 2**	160,000	P	49	H	26	M	S	High TC; presence of E.coli; group representation; accessibility
18	**ABW 3**	90,000	P	54	M	27	M		
19	**ABW 4**	90,000	P	48	H	22	H		
20	**ABW 5**	36,600	P	42	H	22	H		
21	**OKA 1**	21,250		56	M	27	M		
22	**OKA 2**	4,000		52	M	30	M		
23	**OKA 3**	1,500	P	58	M	29	M		
24	**OKA 4**	2,500	A	40	H	23	H		
25	**OKA 5**	550	P	64	M	29	M	S	Presence of E.coli; accessibility
26	**OMD 1**	4,000	P	50	H	20	H		
27	**OMD 2**	800,000	P	30	VH	17	H	S	VH-H risk class;High TC; Presence of E.coli
28	**OMD 3**	45,000	A	64	M	38	L		
29	**OMD 4**	80,000	P	55	M	27	M	S	Presence of E.coli; accessibility
30	**OMD 5**	800,000	P	67	M	26	M		
31	**LFW 1**	275,000	P	24	VH	13	VH		
32	**LFW 2**	800,000	P	45	H	22	H		
33	**LFW 3**	55,000	P	36	H	21	H	S	H risk class; Presence of E.coli; accessibility
34	**LFW 4**	45,000	P	77	L	34	L		
35	**LFW 5**	47,000	P	60	M	29	M		
36	**SKN 1**	1,750	P	66	M	29	M	S	Presence of E.coli; accessibility

37	**SKN 2**	350	A	36	H	18	H	S	High risk class; group representation; accessibility
38	**SKN 3**	12,500	A	34	VH	18	H		
39	**SKN 4**	450	A	32	VH	18	H		
40	**SKN 5**	600	A	45	H	24	H		
41	**LNT 1**	13,750	P	59	M	30	M	S	Presence of E.coli; accessibility
42	**LNT 2**	200	A	41	H	22	H		
43	**ITK 1**	5,500	P	46	H	20	H	S	High risk class; Presence of E.coli; accessibility
44	**ITK 2**	11,250	A	39	H	18	H		
45	**ITK 3**	90,000	P	39	H	16	VH	S	VH - H risk class; High TC;Presence of E.coli; accessibility
46	**ITK 4**	13,000	P	23	VH	15	VH		
47	**ITK 5**	5,500	P	39	H	19	H		
48	**ITK 6**	90,000	P	38	H	21	H		
49	**ITK 7**	160,000	A	35	H	21	H		
50	**ITK 8**	27,500	P	42	H	22	H	S	High risk class; Presence of E.coli; accessibility
51	**ITK 9**	27,500	P	38	H	19	H		
52	**KMT 1**	25,000	P	75	L	29	M	S	Presence of E.coli; accessibility
53	**KMT 2**	5,000	P	64	M	32	M		
54	**KMT 3**	55,000	P	75	L	34	L		
55	**KMT 4**	1,600,000	P	64	M	29	M	S	Very high TC; Presence of E.coli
56	**KMT 5**	1,600	A	79	L	38	L		
57	**EWG 1**	2,500	A	85	L	40	L		

58	**ITE 1**	10,000	P	52	M	26	M		
59	**ITE 2**	35,000	A	57	M	26	M		
60	**ITE 3**	13,000	P	76	L	33	L		
61	**OBK 1**	19,000	P	49	H	24	H		
62	**OBK 2**	4,500	P	56	M	29	M		
63	**OBK 3**	90,000	P	57	M	28	M	S	High TC; presence of E.coli; group representation; accessibility
64	**OBK 4**	22,500	P	64	M	29	M		
65	**OBK 5-1**	5,000	A	56	M	26	M		
66	**OBK 5-2**	400	P	67	M	30	M		
67	**OBK 6**	14,000	A	76	L	36	L		
68	**OBK 7**	2,000	A	81	L	37	L		
69	**OBK 8**	90,000	P	73	L	31	M		
70	**OBK 9**	13,000	P	78	L	31	M	S	Presence of E.coli; accessibility
71	**OBK 10**	900	A	76	L	33	L		
72	**OBK 11**	17,000	P	41	H	19	H	S	High risk class; Presence of E.coli; accessibility
73	**ADG 1**	1,100	A	68	M	34	L		
74	**ADG 2**	6,500	P	54	M	25	M		
75	**ADG 3**	90,000	P	50	H	24	H		
76	**ADG 4**	55,000	P	55	M	32	M		
77	**ADG 5**	22,500	P	64	M	30	M	S	Presence of E.coli; accessibility
78	**ADG 6**	4,000	A	60	M	32	M		
79	**ADG 7**	25,000	P	42	H	20	H	S	High risk class; Presence of E.coli; Group representation; accessibility

80	**ADG 8**	11,000	A	55	M	32	M
81	**ADG 9**	200	A	58	M	30	M
82	**ADG 10**	1,700	P	64	M	34	L

Risk classes for SI 1: VH: 17 – 34; H: 35 – 51; M: 52 – 68; L: 69 – 85; VH: Very high risk; H: High risk; M: Medium risk; L: Low risk; S: Selected well; P: Present; A: Absent; TC: Total coliform; Risk classes for SI 2: VH: 8 – 16; H: 17 – 24; M: 25 – 32; L: 33 - 40

A2.1: Merits and limitations of wells selection for second field visit, 2008

The proposed hand-dug well selection criteria options A, B and C are highlighted herewith:

Option A:

1. Protected well with pump/owner managed or resident owner (P^+)
2. Protected well with dedicated bucket & rope/owner managed (P^-)
3. Protected well; with lining, cover, pump/absent owner (P^-)
4. Semi-protected well +/- owner managed (S)
5. Unprotected well; no lining, no cover, free access, absent owner, not managed (U)

Option A was based on prior well classification made in the research (Table 4.1). The classification in option A is subjective but the descriptions represented the various forms of practices identified with hand dug wells sampled in the first field work.

Option B:

1. Protected with pump/dedicated bucket & rope + owner managed
2. Protected with pump or dedicated bucket & rope – owner managed
3. Protected without dedicated bucket & rope +/- owner managed
4. Semi-protected wells +/- owner managed
5. Unprotected wells; no lining, no cover, free access, absent owner, not managed

Option B tries to simplify the wells classified as P^+ and P^- in option A.

The proposition is to select one well to represent each category or classification, making a total of five wells per cluster and a total of 25 wells in all. Identifying the best fit wells may involve a two to three day reconnaissance survey of the study area to locate wells for any selected category. A major concern however will be finding the best fit wells within each cluster for all clusters. Interview sessions may be planned to target owners and users of selected wells.

Option C:

6. Protected well with pump/owner managed or resident owner (P^+) (1)
7. Protected well with dedicated bucket & rope/owner managed (P^{-1}) (2)
8. Protected well; with lining, cover, no dedicated bucket/absent owner (P^{-2}) (4)
9. Semi-protected well +/- owner managed (S) (11)
10. Unprotected well; no lining, no cover, free access, absent owner, not managed (U) (7)

NB: (1) Indicated the number of wells in the 1st field work that fits into each classification.

In option C, the numbers of wells in the first field work that fits into each well category was inserted in an attempt to judge the importance of each of the well category in the study area.

The proposal is that in the 2nd field work new set of wells and respondent should be interviewed and sampled. Five (5) new wells and by implication five respondents should be interviewed. The number represents a quarter of the previous (1st field work) well selections. The five new wells should be selected randomly anywhere in the study area thru a transect walk. The five wells should fall into the well classification, but it may not be possible to get a well each into each of the five classifications. The objective of introducing new data set is to:

- o Check if more respondents are necessary or not
- o Check if new issues will come up or not
- o Minimise previously introduced bias/researcher's influence to check if it will make any difference or not

The outcome of the new data set will determine whether to increase the new data set to 25 or re-visit the previously selected 25 wells. Re-visiting the existing 25 wells will allow the following:

- o Test proposed water safety framework
- o Comparison of new and previous water quality status of same wells

In terms of interview sessions however, same sets of respondents may not be available for comments for all the well sites.

However, due to time constraints, a lower number of observation wells were recommended. Consequently, the selection criteria were reviewed from a five-point to a three-point criterion, but selection points remained the five research clusters. The original well classification/categories were modified to include type of access as follows:

Class 1/Good: - Protected well/monitored to no access

Class 2/Fair: - Semi-protected/monitored to free access

Class 3/Poor: - Un-protected/free access

It is expected that selection of the new categories of wells from same or previously selected clusters will allow for comparison in the research data analysis.

Table 4-a: Hand dug well classifications based on structure and mode of operation

	Hand dug well structures*				
Well operation	**LCAD**	**LAD**	**CAD**	**LC**	**None**
Pump	P^+	S	S	P^-	U
Bucket/Rope	P^-	S	S	S	U

* Based on existing practices; L: Lining; C: Cover; A: Apron; D: Drainage; P: Protected well; +: best practice; -: Low level protected well; S: Semi-protected; U: Unprotected

Box A1: Merits and limitations of the four proposed options for second filed work well selections

ANNEX 3: McCrady's Statistical Table

Quantity of water	10 ml	1 ml	0·1 ml	
No. of samples of each quantity tested	5	5	5	
Number giving positive reaction (acid and gas)				Probable number of coliform bacilli in 100 ml of water
	0	0	0	0
	0	0	1	2
	0	0	2	4
	0	1	0	2
	0	1	1	4
	0	1	2	6
	0	2	0	4
	0	2	1	6
	0	3	0	6
	1	0	0	2
	1	0	1	4
	1	0	2	6
	1	0	3	8
	1	1	0	4
	1	1	1	6
	1	1	2	8
	1	2	0	6
	1	2	1	8
	1	2	2	10
	1	3	0	8
	1	3	1	10
	1	4	0	11
	2	0	0	5
	2	0	1	7
	2	0	2	9
	2	0	3	12
	2	1	0	7
	2	1	1	9
	2	1	2	12
	2	2	0	9
	2	2	1	12
	2	2	2	14
	2	3	0	12
	2	3	1	14
	2	4	0	15
	3	0	0	8
	3	0	1	11
	3	0	2	13
	3	1	0	11
	3	1	1	14
	3	1	2	17
	3	1	3	20
	3	2	0	14
	3	2	1	17
	3	2	3	20
	3	3	0	17
	3	3	1	20
	3	4	0	20
	3	4	1	25
	3	5	0	25
	4	0	0	13
	4	0	1	17
	4	0	2	20
	4	0	3	25
	4	1	0	17
	4	1	1	20
	4	1	2	25
	4	2	0	20
	4	2	1	25
	4	2	2	30
	4	3	0	25
	4	3	1	35
	4	3	2	40
	4	4	0	35
	4	4	1	40
	4	4	2	45
	4	5	0	40
	4	5	1	50
	4	5	2	55
	5	0	0	25
	5	0	1	30
	5	0	2	45
	5	0	3	60
	5	0	4	75
	5	1	0	35
	5	1	1	45
	5	1	2	65
	5	1	3	85
	5	1	4	115
	5	2	0	50
	5	2	1	70
	5	2	2	95
	5	2	3	120
	5	2	4	150
	5	2	5	175
	5	3	0	80
	5	3	1	110
	5	3	2	140
	5	3	3	175
	5	3	4	200
	5	3	5	250
	5	4	0	130
	5	4	1	170
	5	4	2	225
	5	4	3	275
	5	4	4	350
	5	4	5	425
	5	5	0	250
	5	5	1	350
	5	5	2	550
	5	5	3	900
	5	5	4	1600
	5	5	5	1800+

Source: Cheesbrough (2005): Tropical Health Technology, Norfolk

ANNEX 4: Sanitary Inspection Forms

A4. 1: SI 1 (First modification)

I. Type of Facility: **Hand Dug Well (protected/unprotected)**

5. General information
   - LGA: ……………………………
   - Location: ………………………..

6. Cluster group number: ………………

7. Date of visit: ………………………… Weather at time of visit: …………………………………………………………...

8. Water sample taken? ………………… Sample No.: ………………… Faecal Coliform/100ml: …………………

II. Specific Diagnostic Information for Assessment

SN	Questions	Risk scoring system				
		1	2	3	4	5
1	Is there a latrine within 10 m of the well?					
2	Is the nearest latrine on higher ground than the well?					
3	Is there burial point(s) within 10 m of the well?					
4	Is the nearest burial point on higher ground than the well?					
5	Is there any solid waste dump within 10 m of the well?					
6	Is there any ponding of stagnant water within 2 m of the well?					
7	Is the well drainage channel faulty e. g. broken, allowing ponding or needs cleaning?					
8	Is the fence missing or faulty, which would allow animals in?					
9	Is there animal breeding and animal waste within 10 m of well?					
10	Is the well head protected with cemented apron and floor?					
11	Is the cement less than 1 m in radius around the top of the well?					
12	Are there any cracks in the cement floor around the well?					
13	Is a bucket also in use and left in a place where it could be contaminated?					
14	Is the surface pump loose at the point of attachment to well, which could permit water to enter through to the well?					
15	Is there a well cover?					
16	Is there a well wall lining (cement or ring)?					
17	Are the walls of the well inadequately sealed at any point for 3 m below ground level?					
	Total per unit scores					
	SI score = Sum of total per unit scores: ……../85					

Contamination risk score: 17 - 34 = Very high; 35 - 51 = High; 52 - 68 = Medium; 69 - 85 = Low; Scale of scoring: 1 = poor; 5 = good; Adapted from Godfrey & Howard (2005) and Lloyd, & Helmer (1990)

Remedial action: ……………………………………….

A4.2: Sanitary Inspection Form for Self Supply Wells (SI 2)

I. Type of Facility: **Self Supply Well (protected/unprotected)**

1. General information
   - LGA: ………………………………
   - Location: …………………………..

2. Cluster group number: …………………

3. Date of visit: …………………………… Weather at time of visit: ………………………………………………………….

1. Water sample taken? …………………… Sample No.: ………… …… Faecal Coliform/100ml: ……………….

II. Specific Diagnostic Information for Assessment

SN	Questions	Risk scoring systems				
1	Is there a latrine within 10 m of the well?	1	2	3	4	5
2	Is there burial point(s) within 10 m of the well?					
3	Is there any solid waste dump within 10 m of the well?					
4	Is there well head protection?					
5	Is there animal breeding and animal waste within 10 m of the well?					
6	Is a bucket also in use and left in a place where it could be contaminated?					
7	Is there a well cover?					
8	Is there a well wall lining (cement or ring)?					
	Total per unit scores					
	SI score = Sum of total per unit scores: ………/40					

Contamination risk scores: 8 - 16 = Very high; 17 -24 = High; 25 - 32 = Intermediate; 33 - 40 = Low; Scale of scoring: 1 = poor; 5 = good

Remedial action: ……………………………………………………………………………………………………..

Risk scoring criteria per question:

Q1 & 2:

1. Latrine/soak away distance of < 5 m and on higher ground than well
2. Latrine/soak away distance of < 10 m and on equivalent ground level with well
3. Latrine/soak away distance of < 10 m and on lower ground level than well
4. Latrine/soak away distance of 10 m and on equivalent ground level with well
5. Latrine/soak away distance of > 10 m and on lower ground level than well/No burial site

Q3:

1. High heap solid waste distance of < 5 m
2. High heap solid waste distance of < 10 m
3. Moderate solid waste heap distance of 10 m
4. Low heap solid waste distance of > 10 m
5. No solid waste

Q4:

1. No cement apron, floor and drainage around well head with ponding
2. Well head with apron, but no cement flooring and drainage with ponding
3. Well head with apron, crack in cement flooring and poor drainage
4. Well head apron, crack in cement flooring with good drainage
5. Adequate well head apron with cement flooring and good drainage

Q5:

1. No fence, gate and well head protection with very likely animal invasion
2. No fence, incomplete well head protection with likely animal invasion
3. No fence and gate, moderate well head protection with less likely animal invasion
4. Low fence and gate, good well head protection, not likely animal invasion
5. Adequate well fencing and gate, well head protection and not likely animal invasion

Q6:

1. Users use bucket and rope kept on the floor around well
2. Users come with bucket and rope
3. Users use owners' bucket and rope kept on well
4. Users' use owners' bucket and rope kept indoor
5. Use of bucket and rope kept permanently within the well

Q7:

1. Open well
2. Well cover with large openings and without lock and key
3. Well cover with little openings and with lock and key
4. Airtight well cover without lock and key
5. Airtight well cover with lock and key

Q8:

1. No wall lining
2. Well lining made with blocks and within < 3 m of depth
3. Well lining with rings or cement and within 3 m of depth
4. Well lining with rings from apron to > 3 m of depth
5. Well lining with rings from apron to bottom

Adapted from Godfrey & Howard (2005) and Lloyd & Helmer (1990)

ANNEX 5: Research Interviews and Interviewees Profiles

A5.1: Respondents Profiles

Table A5: Respondents Profiles

Respondents Profiles					
ID	**Sex**	**Age**	**Occupation**	**Education**	**Well ownership status**
R1	F	45	Teaching	2	RU
R2	F	39	Trading	1	RU
R3	M	60	Welder	1	SO
R4	M	25	Decorator	3a	RU
R5	F	80	Trader	0	SO
R6	F	46	Trader	1	RU
R7	F	30	Food vendor	1	NRU
R8	F	40	Civil servant	1	RU
R9	M	61	Traditional medics	2	SO
R10	M	42	Farmer/driver	0	RU
R11	F	25	Food vendor	1	RU
R12	**M**	46	Driver	1	RU
R13	M	15	Student	2	RU
R14	F	NS	NS	NS	Caretaker
R15	M	34	Driver	2	SO
R16	F	22	Trader	2	RU
R17	M	54	Driver	2	RU
R18	M	27	Police officer	3a	RU
R19	F	40	Trader	1	RU
R20	F	30	Trader	2	RU
R21	M	NS	Student	1	RU
R22	F	28	Hairdresser	2	RU
R23	M	70	Trader	2	SO
R24	F	NS	NS	NS	RU
R25	M	75	Retired C. servant	0	SO
R26	F	35	Dress maker	2	RU
R27	F	NS	NS	NS	RU
R28	F	NS	NS	NS	RU
R29	M	47	Security officer	2	RU
R30	M	30	Teacher	3b	SO
R31	F	25	Photographer	2	RU
R32	M	35	Police officer	2	RU
R33	M	37	Police officer	2	RU
R34	M	37	Soldier	2	RU
R35	M	57	Traditional medics	1	RU
R36	F	70	Trader	0	SO
R37	F	NS	NS	NS	RU
R38	F	NS	NS	NS	RU
R39	M	60	Bricklayer	0	SO
R40	F	40	Trader	1	RU
R41	F	66	Retired Food vendor	0	RU
R42	F	27	Trader	2	RU
R43	F	**27**	Trader	1	RU
R44	F	60	Trader	1	SO
R45	F	NS	Food vendor	NS	RU
R46	F	73	Trader	0	SO
R47	F	42	Trader	2	RU

R48	F	49	Trader		1	RU
R49	F	80	Trader		1	SO
R50	F	27	Trader		2	RU
R51	M	40	Traditional medics		2	RU
R52	F	NS	NS	NS		RU
R53	F	40	Tie & dye fabric maker		2	RU
R54	F	72	Tie & dye fabric maker		2	SO
R55	F	65	Tie & dye fabric maker		0	SO
R56	**F**	NS	Tie & dye fabric maker	NS		NRU
R57	F	NS	NS	NS		RU
R58	F	50	Trader	NS		SO
R59	F	30	Trader		2	RU
R60	F	25	Trader		2	RU
R61	M	27	Student	3b		RU
R62	F	50	Trader		0	SO
R63	F	30	Trader		2	RU
R64	M	NS	Islamic Teacher		2	SO
R65	M	44	Lecturer	3b		RU
R66	M	40	Technician	3b		RU
R67	M	12	Student		2	NRU
R68	F	NS	Trader		1	NRU
R69	F	NS	Teacher	3a		RU
R70	M	42	Clergy	3b		SO
R71	F	55	Trader		0	SO
R72	F	38	Trader		2	RU
R73	F	26	Student	3b		RU
R74	M	24	Student	3b		RU
R75	F	31	Hairdresser		2	RU
R76	F	45	Trader		1	RU
R77	F	27	Teacher	3a		RU
R78	M	NS	Technician		1	RU
R79	F	NS	Trader		1	RU
R80	F	75	Retired Nurse		1	SO
R81	F	31	Trader		2	RU
R82	M	24	Apprentice		2	RU
R83	F	80	Trader		1	SO
R84	M	28	Civil servant		3	RU
R85	F	17	Student		2	RU
R86	M	30	Trader		3	SO
R87	F	18	Student		2	RU
R88	M	15	Student		2	RU
R89	F	50	Food vendor		2	SO
R90	M	45	Food milling operator		2	RU
R91	M	24	Trader		2	SO
R92	M	27	Fabric maker (Tie & die)		2	RU
R93	F	38	Civil servant		3	RU
R94	M	36	Trader		1	RU
R95	M	40	Clergy		3	RU
R96	F	50	Teacher/Clergy		3	SO

Educational levels: 0: No formal education; 1: Primary education; 2: Secondary education; 3a: Higher education - National diplomas; 3b: Higher education - University/Polytechnic; SO: Source owner; RU: Resident user; NRU: Non-resident user; F: Female; M: Male; NS: Not specified

A5.2: Respondents interviews (see enclosed CD)

A5.3: Key informant interviews (see enclosed CD)

A5.4: Interview guide

Objective: To find out about source and household water handling

Table A6: Interview guide

Part A: General	Answers	Justification/Importance
1. What do you use the well water for?	Drinking Cooking Bathing Laundry Toileting Household cleaning Others specify	1. Justify the need for WSP 2. Important to set indicator/threshold for why and when to develop WSP for SSS (e.g. if > 5% of population)
2. Do you drink it at all?	Yes No	
o If not why?	Descriptive (D)	
o What do you drink?	Tap water Borehole water ‘Pure water’ Others specify	
o Why do you prefer your choice?	Descriptive	
3. How many people draw/collect water from the well?	D	Source management
o Are they all rightful users of the well?	D	
o If not who authorises access and why?	D	
o What is your own status?	Source owner (SO) Residential user (RU) Non-residential user (NRU)	
4. What time of the day do you draw water from the well?	Morning Evening Mid-day Any time on demand	
o Why?	Descriptive	
5. What do you use to draw water?	Pump Bucket/rope	
o What type of bucket/rope?	Plastic Pail Paint bucket Hausa bucket Others specify	
o What do others (RU/NRU) use	Owner’s bucket	

to draw from the well?	Individual bucket Others specify	
6. How do you look after your well?	D	
o What do you do when the water is bad/dirty?	D	
7. Do you ever have problem with your well?	Yes No	
o How often?		
o What are the problems?	D	
o How did you do?	D	
o Did it solve the problem?	D	
o Could you do anything else/ why not?	D	
o Who else would you have called to solve the problem and why?		
o If you want to re-solve the problem, what would you do differently and why?	D	
8. Where do you keep water in the house?	D	Household water handling
o How do take water from the storage?	Dedicated bailer Un-dedicated bailer	
o Do all household members have access to the storage?	Yes No	
o How do you control/keep children away from playing with the water?	D	
9. What will you do to improve your well and why?	D	1. Source improvement 2. Roles and responsibility
o How will you describe your ideal water source?	D	
o How will you design it and why?	D	
o How will you manage it and why?	D	
o Who will you get involved in the management and why?	D	
10. Do you get information about water related issues/topics?		Support programs
o Do you think you should get it?		
o Who should provide/pass the information?		
o What/how is the best way for you to get information?	Television Radio Newspapers/magazines Inter-personal contacts with neighbours Others specify	
o What time of the day do you enjoy watching television/listen to radio/read newspapers	Morning Afternoon Evening	
11. How do you treat yourself when sick?	D	1. To understand the health impact 2. understand attitude
o How many times have you been sick in the last 6 months?		
o What type of sickness is it?	Malaria Typhoid Diarrheal	

	Others specify	to water safety 3. Justify WSP
o What do you think is responsible for the sickness?	D	
o What medication did you use?	D	
o How long did it last for?		
12. Have you had to treat your children in the last 6 months?	Yes No	
o What was the sickness?	Malaria Typhoid Diarrheal Others specify	
o What was responsible?	D	
o How did you treat them?	D	
Part B: Framework testing(Table A6)		Validate proposed framework
Part C: Well details/Sanitary inspections		1. Well description 2. Risk analysis
1. How old is the well?		
2. Well depth	Measurement (M)	
3. Ground to water level	M	
4. Seasonal behaviour(dry/wet season)	D	
5. Observe well construction details	Well cover(with lock/minus lock) Lining Apron/flooring Drainage	
6.Distance to toilet	M	
7. Distance to burial site	M	
8. Distance to waste dump	M	
9. Distance to drains	M	
Part D: Water sampling		1. Hazard identification 2. Risk analysis
1. Nitrate check	M	
2. pH testing	M	
3. Electrical conductivity	M	
4. Turbidity	M	
5. Water temperature	M	

D: Descriptive; M: Measurements

A5.5: Questions for the verification of the critical control measures

Table A7: Five basic questions to test the feasibility of the recommended control measures for inclusion in proposed water safety framework for self supply wells

Issues to verify/test	Is it possible to make compulsory/enforce:	What benefit will you derived from it?	Who should be responsible?	Why should they be responsible?	What will be your contribution/or in what way will you contribute to the action?
Box A					
1. well construction design/quality					
Box B					
2. Minimum distance of well to toilet/burial site/waste dump/drains 3. Usage of dedicated bucket & rope 4. Washing of hands before taking water from in-house storage 5. usage of in-house storage cover 6. usage of in-house storage bailer					
Box C					
7. Cleaning of well area 8. Source management rules; no talking/no chewing of stick/no climbing on well with shoes 9. Display of & compliance with access time					

10. Monitoring of access time 11. Ban or sanction un-ruly behaviour around well area/source operation 12. Minimum age limit 13. Standard bucket recovery system 14. Locking of well cover when not in use 15. pump installation					
Box D					
16. Household water treatment 17. Monitor water quality status 18. Inspect well handling and hygiene 19. Regulate source management 20. Introduce compulsory support programs					

A5.6: Interviews coding

Table A8: Interview findings: Themes and sub-headings, explanatory remarks and relevant research objectives that the themes cover

	Theme headings and sub-headings	Remarks	Relevant objectives
1	Water uses	Examines actual water uses. It summarises drinking water practices of users, the why and why not of drinking well water, and alternative drinking water. Highlight the number of users that drinks well water. Identifies user-defined uses, both suggesting a link with water quality perception. Many more discussion points, which ends with justification for water safety plans	1
2	Number of users	Estimates of users from interview results. Completes inventory data and may further support the need for WSP for SSS	1
3	Attitude to health impact	Examines the health angle to water safety. May suggest link to sources of contamination and possible hazards to water safety	2
4	Household water handling ▪ Water storage ▪ Household water treatment/attitude	Looks at existing practices at household that might be regarded as control measures to safe guard drinking water	3
5	Source management practices ▪ Source operations ▪ Management problems ▪ Source improvement & roles	Highlights various source management practices in terms of problems, challenges, source operation, and maintenance and source improvements. It also examines all identified roles and responsibilities around source management	4
6	Users' knowledge/awareness (to safety) ▪ Source safety ▪ Water safety ▪ Sources of contamination	Highlights what users know of water safety problems and what they do not know. It would be useful in identifying needed support programs	6
7	Users' willingness to intervention ▪ Actual intervention uptake	This theme put a spot light on the willingness of users to intervention uptake and distinguishing the actual uptake. It may help to suggest and prioritise intervention recommendations.	6
8	Government/PHD intervention ▪ Supporting programs	Identifies the role and responsibilities of government and agencies.	6

PHD: Public Health Department

ANNEX 6: Qualitative Risks Assessment

A6.1: The qualitative risks assessment and description of the 25 observation self supply wells, field visit 2007

1. General information

Well Name:	AMLS 1, Group 1
Location:	Ariyanja Street, Kuto/Amolaso area, Abeokuta
Dates of visits:	10/04/07; 21/05/07; 18/06/07; 16/07/07
Owner's residence status:	Non-resident
Approximate Number of Users:	53 residential users + > 50 others = 103
No. of Respondents:	2
Water use:	Drinking, cooking, bathing, and laundry
Local drinking-water supply:	Tap water, 'Pure water'

Well description

Date of construction:	1991 (16 years)
Static water level:	1.7 m (16/07/07)
Distance to soak away:	15.8 m
Distance to burial site:	None
Well lining:	Unlined
Well cover:	Present, not leak-proof
Well apron:	Missing
Operation:	Multiple well buckets

Total coliform count (mpn/100ml): 3,500 & 17,500 (min & max values of 4 sampling times)

Residential users' responses:

Water is safe enough for drinking; do not get sick from the use of water; will not prevent other users, because water is a common good, they are not the owner, and fear of public abuse. Water safety measures: could insist on use of dedicated bucket when possible, but not ready to invest in other forms of intervention.

Risks assessment:

Hazardous events	Causes	Hazards	Pathway	Likelihood	Impact	Risk score
Ingress of contaminants (rusted particles, dust, debris, waste water) directly into well	Holes in metallic Well cover	Microbes and chemicals (Fe)	Wellhead / surface entry	5	2	10
Direct introduction of contaminants into well	Use of un-kept bucket and rope left indiscriminately around well Use of multiple buckets from hygienically un-ascertained sources/places Hand/surface pump not installed	Microbes Solids	Surface entry	5	4	20
Percolation of waste water into well	Lined public drain 0.3 m from well conveying untreated waste water	Microbes, chemicals	Sub-surface entry (unlined well)	2	4	8
Splashing of waste water into well	Users throwing of waste water into drain 0.3 m from well, and conveying untreated waste water	Untreated waste (microbes, chemicals)	Surface entry	4	2	8
Ponding of wellhead area	Absence of apron	Microbes	Sub-surface entry	5	2	10
						56

2. General information

Well Name: AMLS 2, Group 1
Location: Ariyanja Street, Kuto/Amolaso area, Abeokuta
Dates of visits: 10/04/07; 21/05/07; 18/06/07; 16/07/07
Owner's residence status: Two Resident co-owners
Approximate Number of Users: 105 residential users + > 50 others = 155
No. of Respondents: 4
Water use: Occasional drinking, cooking, bathing, and laundry
Local drinking-water supply: Tap water

Well description

Date of construction: 16/08/2002
Static water level: 3.3 m (16/07/07)
Distance to Toilet: 13 m
Distance to burial site: 9.1m & 11 m (2 no.)
Well lining: Unlined
Well cover: Present, not leak-proof
Well apron: Missing
Operation: Multiple buckets
Total coliform count (mpn/100ml): 5,000 & 17,000 (min & max values of 4 sampling times)

Residential users' responses:

Sometimes we drink and cook with the water, we use it to wash clothes as well…I will not allow the government, since the well does not belong to them…we do not allow anyone to put just anything inside the well, but each resident user has their individual fetcher….we would call ourselves together and make rule that everybody must use one fetcher that we provide…

Risks Assessment:

Hazardous events	**Causes**	**Hazards**	**Pathway**	**Likelihood**	**Impact**	**Risk score**
Ingress of contaminants (rusted particles, dust, debris, waste water) directly into well	Holes in metallic Well cover	Microbes and chemicals (Fe)	Wellhead / surface entry	5	2	10
Direct introduction of contaminants into well	Use of un-kept bucket and rope left indiscriminately around well	Microbes Solids	Surface entry	5	4	20
	Use of multiple buckets from hygienically un-ascertained sources/places					
	Hand/surface pump not installed					
Percolation of waste water into well	Lined public drain 0.3 m from well conveying untreated waste water	Microbes, chemicals	Sub-surface entry (unlined well)	2	4	8
Percolation of organic waste into the well	Nearness of human burial sites on same ground level (64 m) to well	Microbes	Sub-surface entry (unlined well)	2	4	8
Ponding of wellhead area	Absence of apron	Microbes	Sub-surface entry	5	2	10
						56

3. **General information**

Well Name: AMLS 7, Group 1
Location: Baba Eleshin's compound, Abo-Aba Road, Itori Odo, Abeokuta
Dates of visits: 10/04/07; 21/05/07; 18/06/07; 16/07/07
Owner's residence status: Resident
Approximate Number of Users: 40
No. of Respondents: 4
Water use: Cooking, bathing, and laundry
Local drinking-water supply: Tap water

Well description

Date of construction: 2004 (4 years)
Static water level: 2.7 m (16/07/07)
Distance to Toilet: None
Distance to burial site: 0.6 & 4.8 m (distances to the nearest and farthest burial sites; 6 no. in all)
Well lining: Unlined
Well cover: Present; partial & not leak-proof
Well apron: Missing
Operation: Multiple well buckets
Total coliform count (mpn/100ml): 3,500 & 17,000 (min & max values of 4 sampling times)

Residential users' responses:

Source owner claimed he dug the well for public usage. He tries to pay attention to the maintenance but not encouraged due to constant damage of especially the well cover. He however expressed willingness to invest in the repairs (well cover, lining and apron) after rainy season. Residents claimed that many non-resident users drink the water in the absence of tap water

Risks Assessment:

Hazardous events	Causes	Hazards	Pathway	Likelihood	Impact	Risk score
Ingress of contaminants (rusted particles, dust, debris, waste water) directly into well	Partial well covering; Holes in metallic cover	Microbes and chemicals (Fe)	Wellhead / surface entry	5	2	10
Direct introduction of contaminants into well	Use of un-kept bucket and rope left indiscriminately around well; Use of multiple buckets from hygienically un-ascertained sources/places; Hand/surface pump not installed	Microbes Solids	Surface entry	5	4	20
Percolation of human organic wastes into well	Location of 6 grave sites within 1.2 m and 4.8 m on same ground level (65 m) to well	Microbes	Sub-surface entry (unlined well)	5	4	20
Ponding of wellhead area	Absence of apron and drainage	Microbes	Sub-surface entry	5	2	10
Plant and algae growth within and outside un-cemented well head and within unlined well wall	Absence of well lining and cemented wellhead	Chemical	Direct contact	5	2	10
						70

4. **General information**

Well Name:	IJM 1, Group 1
Location:	Lasokun's Compound, Ijemo, Abeokuta
Dates of visits:	11/04/07; 22/05/07; 19/06/07; 17/07/07
Owner's residence status:	Deceased
Approximate Number of Users:	50
No. of Respondents:	3
Water use:	Cooking, bathing, and laundry
Local drinking-water supply:	Tap water

Well description

Date of construction:	1987 (20 years)
Well depth:	3 m
Static water level:	1.2 m (17/07/07)
Distance to soak away:	10 m
Distance to burial site:	5.2 & 7.6 m (distances to the nearest and farthest grave sites; 5 no. in all)
Well lining:	Unlined
Well cover:	None (11/04/07), Present (17/07/07)
Well apron:	Present
Operation:	Multiple buckets
Total coliform count (mpn/100ml):	1,000 & 55,000 (min & max values of 4 sampling times)

Residential users' responses:

The well belonged to a family clan, which is now spread into at least four blocks of houses, which has the well located to the centre. The well is not the direct responsibility of any family member per se, but the eldest family member is expected to summon others for contribution towards the maintenance. During the research period however, a woman volunteer from the family clan paid for the repairs of the well cover. The well is opened to non-resident users as well.

Risks assessment:

Hazardous events	**Causes**	**Hazards**	**Pathway**	**Likelihood**	**Impact**	**Risk score**
Ingress of contaminants (debris, dust, waste water) directly into well	Absence of well covering (initially) No-seal proof and gaps in wooden cover	Microbes Solids	Wellhead / surface entry	5	2	10
Direct introduction of contaminants into well	Use of multiple buckets from hygienically un-ascertained sources/places Un-kept well area Hand/surface pump not installed	Microbes	Surface entry	5	4	20
Percolation of faecal contamination into well	Location of soak away pit 10 m from and at higher level (108 m) to well (104 m)	Microbes	Sub-surface entry (unlined well)	2	4	8
Percolation of human organic wastes into well	Location of 5 grave sites within 5.2 m and 7.6 m on same ground level (104 m) to well	Microbes	Sub-surface entry (unlined well)	3	4	12
Ponding of well area	Un-kept well area and presence of unlined drainage path carrying un-treated household waste water	Microbes	Sub-surface entry	5	3	15
						65

5. General information

Well Name:	IJM 2, Group 1
Location:	Behind IJM 1, Ijemo-Ake road, Abeokuta
Dates of visits:	11/04/07; 22/05/07; 19/06/07; 17/07/07
Owner's residence status:	Deceased
Approximate Number of Users:	9 residential users + > 50 others = 59
No. of Respondents:	4
Water use:	Cooking, bathing, and laundry
Local drinking-water supply:	Tap water

Well description

Date of construction:	1979 (28 years)
Static water level:	0.9 m (17/07/07)
Distance to pit latrine:	12.1 m
Distance to burial site:	7 m (to the nearest of 6 grave sites)
Well lining:	Unlined
Well cover:	Present, not leak-proof
Well apron:	Missing
Operation:	Multiple buckets

Total coliform count (mpn/100ml): 4,000 & 160,000 (min & max values of 4 sampling times)

Residential users' responses:

Residential users are concerned about the sanitary condition of well, but claimed that they do not have control over the well or the neighbour's usage of the well area. The drainage waste water is generated from a neighbouring house, whose landowner is not interested in investing in proper drainage. IJM 2 well owner is diseased and the Owner's son is usually never around. He (owner's son) however promised to re-construct the drainage channel.

Risks assessment:

Hazardous events	Causes	Hazards	Pathway	Likelihood	Impact	Risk score
Ingress of contaminants (rusted particles, dust, debris, waste water) directly into well	No-seal proof in metallic cover	Microbes Solids	Wellhead / surface entry	5	2	10
Ingress of storm water through gap between wellhead and ground surface	Gap between wellhead and ground surface due to missing apron and flooring	Microbes	Surface entry	5	3	15
Direct introduction of contaminants into well	Use of multiple buckets from hygienically un-ascertained sources/places Un-kept well area Hand/surface pump not installed	Microbes Solids	Surface entry	5	4	20
Percolation of faecal contamination into well	Location of soak away pit 12.1 m from and at higher level (117 m) to well (108 m)	Microbes	Sub-surface entry (unlined well)	2	4	8
Percolation of human organic wastes into well	Location of 6 grave sites within 7 m and at higher ground level (113 m) to well	Microbes	Sub-surface entry (unlined well)	3	4	12
Ponding of well area	Un-kept well area, missing well apron and presence of unlined drainage channel carrying un-treated household waste water	Microbes	Sub-surface entry	5	4	20
						85

6. **General information**

Well Name: IJM 3, Group 1
Location: Agbaje's Compound, Ijemo, Abeokuta
Dates of visits: 11/04/07; 22/05/07; 19/06/07; 17/07/07
Owner's residence status: Diseased
Approximate Number of Users: 12 residential users + > 20 others = 32
No. of Respondents: 2
Water use: Cooking, bathing, and laundry
Local drinking-water supply: Tap water

Well description

Date of construction: 2000 (7 years)
Well depth: 5.5 m
Static water level: 2.1 m (17/07/07)
Distance to toilet: None
Distance to burial site: 7.3 m
Well lining: Ring lining
Well cover: Present
Well apron: Missing
Operation: Multiple buckets
Total coliform count (mpn/100ml): 1,700 & 55,000 (min & max values of 4 sampling times)
(Presence of both E. coli and Clostridium in water samples taken 11/04/07)

Residential users' responses:

There is no co-operation between the residential users. One of the respondent is displeased about the un-hygienic handling of the well and the well area. She is however un-popular as a result of her hygiene campaign. During one of researcher's visits, she invited a particular co-residential user, who according to her is the most un-co-operative – *'' I want my neighbour to hear this, she bath her children just by the well and her child's potty is left permanently by the well, and she sees nothing wrong in drying her laundry on the line close to the well, meanwhile we all at least cook with the well water….''*

Risk assessment:

Hazardous events	Causes	Hazards	Pathway	Likelihood	Impact	Risk score
Ingress of contaminants (rusted particles, dust, debris, waste water) directly into well	Detached metallic well cover Users forget to replace detached cover after drawing Users laundry line positioned across well	Microbes, chemicals, and solids	Wellhead / surface entry	5	4	20
Birds/hens faeces enter through open well	Free range hens abode on a tree with crown over the well Users forget to replace detached cover after drawing	Microbes	Wellhead / surface entry	5	4	20
Direct introduction of contaminants into well	Use of un-kept bucket and rope left indiscriminately around well Use of multiple buckets from hygienically un-ascertained sources/places Hand/surface pump not installed	Microbes Solids	Surface entry	5	4	20
Percolation of human organic wastes and faecal contaminants into well	Location of a grave site within 7 m distance and on higher (107 m) ground level (102 m) to well Bathing, toileting and laundry activities by the well area	Microbes Chemicals	Sub-surface entry	5	4	20
Ponding of wellhead area	Absence of apron and drainage	Microbes	Sub-surface entry	5	2	10
						90

7. **General information**

Well Name: IJM 5, Group 1
Location: Ijemo-Ijako Road, Abeokuta
Dates of visits: 11/04/07; 22/05/07; 19/06/07; 17/07/07
Owner's residence status: Resident
Approximate Number of Users: 30 residential users
No. of Respondents: 2
Water use: Cooking, bathing, and laundry
Local drinking-water supply: Tap water, 'Pure water'[46]

Well description

Date of construction: 1973 (34 years)
Static water level: 1.8 m (17/07/07)
Distance to toilet: 10 m
Distance to burial site: None
Well lining: Natural rock lining
Well cover: Absent
Well apron: Present
Operation: Multiple buckets
Total coliform count (mpn/100ml): 2,500 & 160,000 (min & max values of 4 sampling times)

Residential users' responses:

The source owner has this to say about his well - *''…We don't drink it at all, so I may not be bothered as such… we are just using it for domestic purposes, even those who come from outside the house to fetch the water don't drink it and the water is clean enough for what it's been used for….''*

[46] Usually 0.5 ml sachet water packed as drinking-water

Risks assessment:

Hazardous events	Causes	Hazards	Pathway	Likelihood	Impact	Risk score
Ingress of contaminants (debris, dust, waste water) directly into well	Un-covered well Users laundry line positioned close to well	Microbes Chemicals	Wellhead / surface entry	5	2	10
Direct introduction of contaminants into well	Use of un-kept bucket and rope left indiscriminately around well Use of multiple buckets from hygienically un-ascertained sources/places Hand/surface pump not installed	Microbes Solids	Surface entry	5	4	20
Percolation of faecal contaminants into well	Toilet located 10 m from well	Microbes	Sub-surface entry	2	4	8
Pool of waste water in cracks and holes on cemented floor	Bathing and laundry activities by the well area	Microbes Chemicals	Sub-surface entry	5	2	10
						48

8. General information

Well Name: ABW 2, Group 1
Location: Iga Soyombo Street, Ijeun-Titun, Abeokuta
Dates of visits: 23/04/07; 21/05/07; 18/06/07; 16/07/07
Owner's residence status: Resident
Approximate Number of Users: 30 residential users
No. of Respondents: 4
Water use: Cooking, bathing, and laundry
Local drinking-water supply: Tap water

Well description

Date of construction: 08/06/87 (20 years)
Well depth: 5 m
Static water level: 2.4 m (16/07/07)
Distance to toilet: 12 m
Distance to burial site: None
Well lining: Unlined
Well cover: Present
Well apron: Missing
Operation: Multiple buckets
Total coliform count (mpn/100ml): 25,000 & 160,000 (min & max values of 4 sampling times)

Residential users' responses:

According to the owner's son, necessary steps are being planned to repair the well – ''*….as for the well cover, we are undergoing renovation now and we will put it in mind. We will take all the steps to safe guard the water....''*

Risks assessment:

Hazardous events	**Causes**	**Hazards**	**Pathway**	**Likelihood**	**Impact**	**Risk score**
Ingress of contaminants (debris, dust, waste and storm water) directly into well	No-seal proof and see-through gaps in wooden cover	Microbes Solids	Wellhead / surface entry	5	2	10
Direct introduction of contaminants into well	Use of multiple buckets from hygienically un-ascertained sources/places Hand/surface pump not installed	Microbes Solids	Surface entry	5	4	20
Percolation of faecal contamination into well	Location of soak away pit 12 m away from well	Microbes	Sub-surface entry (unlined well)	2	4	8
Ponding of well area	Absence of apron	Microbes	Sub-surface entry	5	2	10
Algae growth on well head crack areas	Cracks and gaps in cemented wellhead	Chemical	Direct contact	5	2	10
						58

9. General information

Well Name: OKA 5, Group 1
Location: Old Blue house, opp. Alayo Clinic, Oke-Aregba, Abeokuta
Dates of visits: 16/04/07; 21/05/07; 18/06/07; 16/07/07
Owner's residence status: Non-resident
Approximate Number of Users: 27 residential users + 10 others = 37
No. of Respondents: 2
Water use: Cooking, bathing, and laundry
Local drinking-water supply: Tap water

Well description

Date of construction: 2004 (3 years)
Static water level: 3.3 m (16/07/07)
Distance to toilet: 14 m
Distance to burial site: None
Well lining: Unlined
Well cover: Partial cover
Well apron: Present
Operation: Multiple buckets
Total coliform count (mpn/100ml): 550 & 13,000 (min & max values of 4 sampling times)

Residential users' responses:

No evidence of well management. Residents see the well as an alternative source that is good only for non-consumption household purposes.

Risks assessment:

Hazardous events	**Causes**	**Hazards**	**Pathway**	**Likelihood**	**Impact**	**Risk score**
Ingress of contaminants (rusted particles, dust, debris, waste and storm water) directly into well	Partially covered well	Microbes Solids	Wellhead / surface entry	5	2	10
Direct introduction of contaminants into well	Use of un-kept bucket and rope left indiscriminately around well Use of multiple buckets from hygienically un-ascertained sources/places Un-kept well area Hand/surface pump not installed	Microbes	Surface entry	5	4	20
Percolation of faecal contamination into well	Location of soak away pit 14 m away from well	Microbes	Sub-surface entry (unlined well)	2	4	8
Algae growth on unlined wall	Absence of well lining	Chemical	Direct contact	5	2	10
						48

10. General information

Well Name: OMD 2, Group 2
Location: Araba's Compound, Omida, Abeokuta
Dates of visits: 19/04/07; 23/05/07; 20/06/07; 17/07/07
Owner's residence status: Resident
Approximate Number of Users: 20 residential users
No. of Respondents: 2
Water use: Cooking, bathing, and laundry
Local drinking-water supply: Tap water, protected well

Well description

Date of construction: 1987 (20 years)
Well depth: 1.5 m
Static water level: 0.6 m (17/07/07)
Distance to pit latrine: 14 m
Distance to burial site: 6.1 m (2 no.)
Well lining: Block lining
Well cover: Un-covered
Well apron: Missing
Operation: Multiple buckets
Total coliform count (mpn/100ml): 5,500 & 800,000 (min & max values of 4 sampling times)

Residential users' responses:

The source owner recognised the need to improve the well but claimed that the means (money) is not available. Residential users depend on the well water for non-consumptive household uses because the well is within reach, they however fetch drinking water from a protected well across the road or from tap water when it is available.

Risks assessment:

Hazardous events	**Causes**	**Hazards**	**Pathway**	**Likelihood**	**Impact**	**Risk score**
Ingress of contaminants (rusted and asbestos particles, dust, debris, storm and waste water) directly into well	Un-covered well Placement of broken asbestos and metallic slates as make-shift cover	Microbes and chemicals	Wellhead / surface entry	5	4	20
Ingress of storm water into well	Low-level well head (0.3 m from ground level)	Microbes Solids	Wellhead / surface entry	5	4	20
Direct introduction of contaminants into well	Use of un-kept bucket and rope left indiscriminately around well Use of multiple buckets from hygienically un-ascertained sources/places Hand/surface pump not installed	Microbes Solids	Surface entry	5	4	20
Percolation of human organic wastes into well	Location of 2 grave sites, both at 6.1 m from and at higher ground level (64 m) to the well (60 m)	Microbes	Sub-surface entry	5	4	20
Entry/in-flow of contaminated water	Well located 3.3 m from Lakasha stream	Microbes	Sub-surface entry	5	4	20
Ponding of wellhead area	Absence of apron and drainage	Microbes	Sub-surface entry	5	2	10
Algae growth within and outside un-cemented block lining	Absence of well lining and cemented wellhead	Chemical	Direct contact	5	2	10
						120

11. General information

Well Name: OMD 4, Group 2
Location: Sagbami's Compound, Omida, Abeokuta
Dates of visits: 19/04/07; 23/05/07; 20/06/07; 17/07/07
Owner's residence status: Resident
Approximate Number of Users: 10 residential users + > 100 = 110
No. of Respondent: 1
Water use: Cooking, bathing, and laundry
Local drinking-water supply: Tap water, protected well

Well description

Date of construction: 2002 (5 years)
Static water level: 0.9 m (17/07/07)
Distance to pit latrine: 7.6 m
Distance to burial site: 2.7 m
Well lining: Unlined
Well cover: Present
Well apron: Partial
Operation: Single bucket
Total coliform count (mpn/100ml): 8,500 & 160,000 (min & max values of 4 sampling times)

Residential users' responses:

This well is an example of an owner managed well. The owner appears passionate about hygiene around the well. He explained that the well was constructed for laundry, bathing and household cleaning, but ''*laundry takes most of the water*''. The burial site was made in 1985, about 18 years to when the well was constructed. He however argued that 18 years is long enough to drain any organic waste that could be generated from the burial point. He also noted that the well is at a higher level (68 m) to the pit latrine (61 m) and hence expected no interference.

Risks assessment:

Hazardous events	**Causes**	**Hazards**	**Pathway**	**Likelihood**	**Impact**	**Risk score**
Ingress of contaminants (rusted particles, storm water) directly into well	Storm water drips from building wall that terminates on well head through openings in rusted hinges on metallic cover	Microbes chemicals	Wellhead / surface entry	2	2	4
Direct introduction of contaminants into well	Usage of bucket and rope Hand/surface pump not installed	Microbes	Surface entry	4	4	16
Percolation of faecal contamination into well	Location of pit latrine 7.6 m, but at a lower level (61 m) to well (68 m)	Microbes	Sub-surface entry (unlined well)	2	4	8
Percolation of human organic wastes into well	Location of grave site 2.7 m to well	Microbes	Sub-surface entry (unlined well)	5	4	20
Ponding of well area	Grassy and un-cemented portion of well area Laundry activities near the well	Microbes	Sub-surface entry	5	2	10
						58

12. General information

Well Name: LFW 3, Group 2
Location: 11b, Abule Otun, Lagos Road, Lafenwa, Abeokuta
Dates of visits: 19/04/07; 23/05/07; 26/06/07; 18/07/07
Owner's residence status: Deceased
Approximate Number of Users: 15 residential users + > 100 others = 115
No. of Respondents: 2
Water use: Bathing and laundry
Local drinking-water supply: Tap water

Well description

Date of construction: 1977 (30 years)
Well depth: 1.2 m
Static water level: 0.3 m (18/07/07)
Distance to pit latrine: 6.7 m
Distance to burial site: None
Well lining: Unlined
Well cover: Block lining
Well apron: Missing
Operation: Multiple buckets
Total coliform count (mpn/100ml): 13,000 & 160,000 (min & max values of 4 sampling times)

Residential users' responses:

According to the owner's son, necessary steps are being planned to repair the well – ''….*as for the well cover, we are undergoing renovation now and we will put it in mind. We will take all the steps to safe guard the water....''*

Risks assessment:

Hazardous events	**Causes**	**Hazards**	**Pathway**	**Likelihood**	**Impact**	**Risk score**
Ingress of contaminants (dust, debris, storm and waste water) directly into well	Un-covered well	Microbes Solids	Wellhead / surface entry	5	4	20
Ingress of storm water into well	Low-level well head (0.3 m from ground level) Building wall flushes with well head Building roof positioned across well	Microbes	Wellhead / surface entry	5	4	20
Direct introduction of contaminants into well	Use of multiple buckets from hygienically un-ascertained sources/places Hand/surface pump not installed	Microbes Solids	Surface entry	5	4	20
Percolation of faecal contamination into well	Location of pit latrine 6.7 m, but at a lower level (60 m) to well (66 m)	Microbes	Sub-surface entry	2	4	8
Ponding of wellhead area	Absence of apron and drainage	Microbes	Sub-surface entry	5	2	10
Algae growth within and outside un-cemented block lining	Absence of well lining and cemented wellhead	Chemical	Direct contact	5	2	10
						88

13. General information

Well Name: LNT 1, Group 3
Location: Opposite Sacred Heart Hospital, Lantoro, Abeokuta
Dates of visits: 17/04/07; 24/05/07; 27/06/07; 17/07/07
Owner's residence status: Resident
Approximate Number of Users: 50
No. of Respondents: 1
Water use: Cooking, bathing and laundry
Local drinking-water supply: Tap water and pure water

Well description

Date of construction: 07/07/2006 (1 year)
Well depth: 5.4 m
Static water level: 0.9 m (17/07/07)
Distance to pit latrine: 10.3 m
Distance to burial site: None
Well lining: Ring lining
Well cover: Present
Well apron: Present
Operation: Dedicated bucket
Total coliform count (mpn/100ml): 200 & 160,000 (min & max values of 4 sampling times)

Residential users' responses:

Dedicated bucket is the initiative of the source owner, who sees the well as an alternative source. The source is however a source of water for uses that includes cooking and occasional drinking for the residential users and neighbours; who saw this well as a better (in terms of construction and management) well to their source.

Risks assessment:

Hazardous events	Causes	Hazards	Pathway	Likelihood	Impact	Risk score
Ingress of contaminants (rusted particles and storm water) directly into well	Gaps between wellhead and metallic cover	Microbes	Wellhead / surface entry	2	4	8
Direct introduction of contaminants into well	Hand/surface pump not installed	Microbes Solids	Surface entry	2	4	8
Percolation of faecal contamination into well	Location of pit latrine 10.3 m, at a higher level (96 m) to well (94 m)	Microbes	Sub-surface entry	2	4	8
Ponding of area around well	Lack of drainage channel and laundry activities within well area	Microbes	Sub-surface entry	5	2	10
						34

14. General information

Well Name: SKN 1, Group 3
Location: Sokenu's Compound, Kolade Street, Oke-Ijeun, Abeokuta
Dates of visits: 17/04/07; 24/05/07; 27/06/07; 16/07/07
Owner's residence status: Resident
Approximate Number of Users: 11 residential users + > 20 others = 31
No. of Respondents: 2
Water use: Cooking, bathing and laundry
Local drinking-water supply: Tap water and pure water

Well description

Date of construction: 1972 (35 years)
Well depth: 4 m
Static water level: 3.6 m (16/07/07)
Distance from soak away: 13.3 m
Distance to burial site: None
Well lining: No lining
Well cover: Present
Well apron: Present
Operation: Multiple buckets
Total coliform count (mpn/100ml): 1,750 & 160,000 (min & max values of 4 sampling times)

Residential users' responses:

One of the responses from a residential user in this location captures the link between water usage and attitude to source improvement – ''*… we can not invest in source improvement without the finance …and it is not like we drink the water, we just use it for domestic works…*''

Risks assessment:

Hazardous events	**Causes**	**Hazards**	**Pathway**	**Likelihood**	**Impact**	**Risk score**
Ingress of contaminants (debris, dust, waste and storm water) directly into well	No-seal proof and see-through gaps in wooden cover	Microbes Solids	Wellhead / surface entry	5	2	10
Direct introduction of contaminants into well	Use of multiple buckets from hygienically un-ascertained sources/places; Hand/surface pump not installed	Microbes Solids	Surface entry	5	4	20
Percolation of faecal contamination into well	Location of soak away pit 13.3 m away but on a higher (90 m) ground level to well (79 m)	Microbes	Sub-surface entry (unlined well)	2	4	8
Algae growth on wooden cover	Water in contact with wooden cover	Chemical	Direct contact	5	2	10
						48

15. General information

Well Name:	SKN 2, Group 3
Location:	Hassan's compound, Kolade Street, Oke-Ijeun, Abeokuta
Dates of visits:	17/04/07; 24/05/07; 27/06/07; 16/07/07
Owner's residence status:	Deceased
Approximate Number of Users:	25 residential users + > 50 others = 75
No. of Respondents:	2
Water use:	Cooking, bathing and laundry
Local drinking-water supply:	Tap water

Well description

Date of construction:	1977 (30years)
Well depth:	4.8 m
Static water level:	3.3 m (16/07/07)
Distance from pit latrine:	15.8 m
Distance to burial site:	3 m
Well lining:	No lining
Well cover:	Present
Well apron:	Missing
Operation:	Multiple buckets

Total coliform count (mpn/100ml): 350 & 90,000 (min & max values of 4 sampling times)

Residential users' responses:

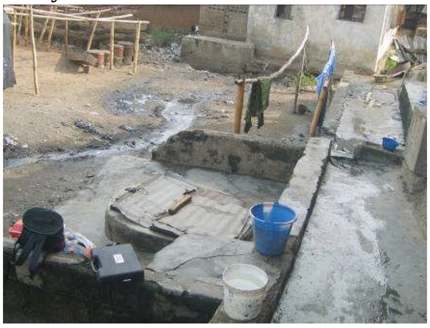
Source maintenance and repairs has to go through some form of family bureaucracy; the late source owner's wife has to consult with other family members before any action can be taken concerning the well.

Risks assessment:

Hazardous events	Causes	Hazards	Pathway	Likelihood	Impact	Risk score
Ingress of contaminants (rusted particles, dust, debris, waste and storm water) directly into well	No-seal proof and see-through gaps between cover and well head	Microbes, Chemicals and solids	Wellhead / surface entry	5	4	20
Direct introduction of contaminants into well	Usage of un-kept bucket and rope left indiscriminately around well Usage of multiple buckets from hygienically un-ascertained sources/places Un-kept well area Hand/surface pump not installed	Microbes Solids	Surface entry	5	4	20
Percolation of faecal contamination into well	Location of pit latrine pit 16 m from and at higher level (87 m) to well (80 m)	Microbes	Sub-surface entry (unlined well)	2	4	8
Percolation of human organic wastes into well	Location of a grave site 3 m on same ground level (80 m) to well	Microbes	Sub-surface entry (unlined well)	5	4	20
Ponding of well area	Apron constructed half-way round the well Un-kept well area	Microbes	Sub-surface entry	5	2	10
Elevated turbidity	Lack of well lining Multiple users at peak drawing time (Morning)	Microbes Turbidity Colour	Direct contact	5	3	15
Loss of multiple buckets into well	Un-monitored well operation and multiple users	Microbes Solids	Surface entry	4	2	8
						101

16. General information

Well Name: ITK 1, Group 4
Location: Ologunebi's Compound, Ifote-Itoku, Abeokuta
Dates of visits: 18/04/07; 24/05/07; 26/06/07; 18/07/07
Owner's residence status: Deceased
Approximate Number of Users: 19 residential users + > 50 others = 69
No. of Respondents: 1
Water use: Bathing, toileting, laundry and tie & dye business
Local drinking-water supply: Tap water



Well description

Date of construction: 1987 (20 years)
Static water level: 0.6 m (18/07/07)
Distance to toilet: None
Distance to burial site: 7.3 m
Well lining: Ring lining
Well cover: Present
Well apron: Present
Operation: Multiple buckets
Total coliform count (mpn/100ml): 900 & 5,500 (min & max values of 4 sampling times)

Residential users' responses:

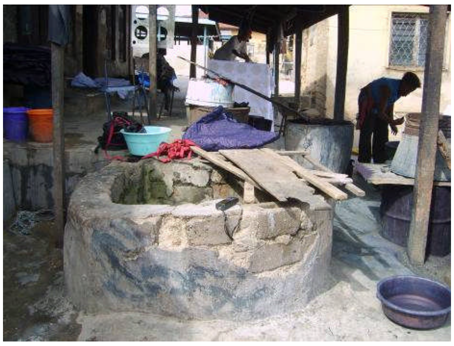
According to the respondent, a residential user, the major problem with the well site is that of solid waste dump. Due to the proximity of the residence to a waterway, residents usually wake up to find household refuse within the well area

Risks assessment:

Hazardous events	Causes	Hazards	Pathway	Likelihood	Impact	Risk score
Ingress of contaminants (rusted particles, dust, debris, waste and storm water) directly into well	No-seal proof and see-through gaps between cover and well head Toileting and laundry activities on an elevated platform above well	Microbes, Chemicals and solids	Wellhead / surface entry	5	4	20
Ingress of storm water into well	Low-level well head (0.3 m from ground level)	Microbes Solids	Wellhead / surface entry	5	4	20
Direct introduction of contaminants into well	Usage of un-kept bucket and rope left indiscriminately around well Usage of multiple buckets from hygienically un-ascertained sources/places Un-kept well area Hand/surface pump not installed	Microbes Solids	Surface entry	5	4	20
Percolation of human organic wastes into well	Location of a grave site 7.3 m on higher (75 m) ground level to well (73 m)	Microbes	Sub-surface entry	2	4	8
Percolation of un-treated dye and household waste water into well	Un-lined drainage within 3 m of well area Un-lined waterway within 7.5 m of well area	Chemicals Microbes	Sub-surface entry	5	4	20
Algae growth within un-cemented block well head and wooden frame cover	Un-cemented block wellhead and constant contact of wooden frame with water	Microbes	Direct contact	5	2	10
						98

17. General information

Well Name: ITK 3, Group 4
Location: 16, Jojolola Court, Kemta- Idaro, Itoku, Abeokuta
Dates of visits: 18/04/07; 24/05/07; 26/06/07; 18/07/07
Owner's residence status: Resident
Approximate Number of Users: 50 users
No. of Respondents: 2
Water use: Laundry and tie & dye business
Local drinking-water supply: Tap water



Well description

Date of construction: 1981 (26 years)
Well depth: 2.4 m
Static water level: 2 m (18/07/07)
Distance to toilet: None
Distance to burial site: 3.9 m
Well lining: No lining
Well cover: Un-covered
Well apron: Present
Operation: Multiple buckets
Total coliform count (mpn/100ml): 1,000 & 90,000 (min & max values of 4 sampling times)

Residential users' responses:

This well location represents another example where source improvement is linked with water usage.

Risks assessment:

Hazardous events	**Causes**	**Hazards**	**Pathway**	**Likelihood**	**Impact**	**Risk score**
Ingress of contaminants (debris, dust, waste and storm water) directly into well	Un-covered well Laundry and fabrics dyeing activities on an elevated platform above and around well	Microbes, Chemicals and solids	Wellhead / surface entry	5	4	20
Ingress of storm water into well	Building roof edges positioned across well	Microbes Chemicals Solids	Wellhead / surface entry	5	4	20
Direct introduction of contaminants into well	Usage of un-kept bucket and rope left indiscriminately around well Usage of multiple buckets from hygienically un-ascertained sources/places Un-kept well area Hand/surface pump not installed	Microbes Solids	Surface entry	5	4	20
Percolation of human organic wastes into well	Location of a grave site 3.9 m on higher (63 m) ground level to well (61 m)	Microbes	Sub-surface entry	4	4	16
Percolation of un-treated dye and household waste water into well	Un-lined drainage within 5 m of well area Un-lined waterway within 7.5 m of well area Waste water from fabrics dyeing thrown indiscriminately around well area	Chemicals Microbes	Sub-surface entry	5	4	20
Elevated turbidity	Broken portion of cemented well lining	Microbes Turbidity Colour	Direct contact	5	2	10
Algae growth within partially cemented well lining and wellhead	Exposure of well lining to the atmosphere due to un-covered well	Microbes	Direct contact	5	2	10
						116

18. General information

Well Name:	ITK 8, Group 4
Location:	4, Kemta Odutolu Street, Itoku, Abeokuta
Dates of visits:	18/04/07; 24/05/07; 26/06/07; 18/07/07
Owner's residence status:	Deceased
Approximate Number of Users:	50 residential users
No. of Respondents:	2
Water use:	Bathing, toileting, laundry and tie & dye business
Local drinking-water supply:	Tap water

Well description

Date of construction:	1957 (50 years)
Well depth:	1.4 m
Static water level:	1.2 m (18/07/07)
Distance to toilet:	None
Distance to burial site:	1.8 m
Well lining:	Block lining
Well cover:	Partial cover
Well apron:	Missing
Operation:	Multiple buckets

Total coliform count (mpn/100ml): 3,500 & 55,000 (min & max values of 4 sampling times)

Residential users' responses:

The residential users claimed that the well is been cleaned up as frequently as possible depending on how dirty it is. There is a particular boy member of the household who climbs down into the well, empty the water and clean the well up.

Risks assessment:

Hazardous events	**Causes**	**Hazards**	**Pathway**	**Likelihood**	**Impact**	**Risk score**
Ingress of contaminants (rusted particles, dust, debris, waste and storm water) directly into well	Well partially covered with rusted and damaged corrugated roofing sheets Bathing and laundry activities by the well area	Microbes, Chemicals and solids	Wellhead / surface entry	5	4	20
Ingress of storm water into well	Well located below and between two un-piped building roof edges Low-level wellhead (0.3 m above ground level)	Microbes Chemicals Solids	Wellhead / surface entry	5	4	20
Direct introduction of contaminants into well	Usage of un-kept bucket and rope left indiscriminately around well Usage of multiple buckets from hygienically un-ascertained sources/places Hand/surface pump not installed	Microbes Solids	Surface entry	5	4	20
Percolation of human organic wastes into well	Location of a grave site 1.8 m on same ground level (61 m) with well	Microbes	Sub-surface entry	4	4	16
Algae growth within and outside un-cemented block lining and wellhead	Exposure of well lining to the atmosphere due to partial covering	Microbes	Direct contact	5	2	10
						86

19. <u>General information</u>

Well Name: ADG 5, Group 5
Location: 2, Ogunbumi Street, Saraki-Adigbe, Abeokuta
Dates of visits: 26/04/07; 23/05/07; 20/06/07; 18/07/07
Owner's residence status: Non-resident
Approximate Number of Users: 40 residential users + > 20 others = 60
No. of Respondents: 3
Water use: Drinking, cooking, bathing, toileting and laundry
Local drinking-water supply: Tap water and pure water

<u>Well description</u>

Date of construction: 1987 (20 years)
Well depth: 4.5 m
Static water level: 1.5 m (18/07/07)
Distance to soak away pit: 13 m
Distance to burial site: None
Well lining: Ring lining
Well cover: Present
Well apron: Present
Operation: Multiple buckets
Total coliform count (mpn/100ml): 4,500 & 22,500 (min & max values of 4 sampling times)

<u>Residential users' responses:</u>

The source owner and the residential users here acted promptly to adopt safety interventions. The owner initiated pebbled-lined well bottom to reduce turbidity or water colour. He also invited a bricklayer to re-construct the well area in a way to deflect waste water while the residential users adopted the usage of dedicated bucket.

<u>Risks assessment:</u>

Hazardous events	**Causes**	**Hazards**	**Pathway**	**Likelihood**	**Impact**	**Risk score**
Ingress of contaminants (rusted particles, dust, debris, waste water) directly into well	Holes in metallic Well cover	Microbes and chemicals (Fe)	Wellhead / surface entry	5	2	10
Direct introduction of contaminants into well	Use of un-kept bucket and rope left indiscriminately around well	Microbes Solids	Surface entry	5	4	20
	Use of multiple buckets from hygienically un-ascertained sources/places					
	Un-kept well area					
	Hand/surface pump not installed					
Ponding of wellhead area	Absence of drainage	Microbes	Sub-surface entry	5	2	10
						40

20. General information

Well Name: ADG 7, Group 5
Location: Ogunbodede close, Saraki-Adigbe, Abeokuta
Dates of visits: 26/04/07; 23/05/07; 20/06/07; 18/07/07
Owner's residence status: Resident
Approximate Number of Users: 10 residential users + > 20 others = 30
No. of Respondents: 2
Water use: Cooking, bathing, toileting and laundry
Local drinking-water supply: Neighbour's well and pure water

Well description

Date of construction: 1992 (15 years)
Well depth: 2.7 m
Static water level: 1.5 m (18/07/07)
Distance to toilet: 11 m
Distance to burial site: 0.5 m
Well lining: No lining
Well cover: Partial cover
Well apron: Missing
Operation: Multiple buckets
Total coliform count (mpn/100ml): 2,500 & 35,000 (min & max values of 4 sampling times)

Residential users' responses:

The source owner is not in a hurry to invest in source improvement because the next door neighbour has a protected well, which they (owner and residents) have free access to.

Risks assessment:

Hazardous events	**Causes**	**Hazards**	**Pathway**	**Likelihood**	**Impact**	**Risk score**
Ingress of contaminants (rusted particles, dust, debris, waste and storm water) directly into well	Partial well covering with iron and metallic cover	Microbes and Chemicals (Fe), Solids	Wellhead / surface entry	5	4	20
	Well located below un-piped roof edges					
Direct introduction of contaminants into well	Use of un-kept bucket and rope left indiscriminately around well	Microbes Solids	Surface entry	5	4	20
	Use of multiple buckets from hygienically un-ascertained sources/places					
	Hand/surface pump not installed					
Percolation of human organic wastes into well	Location of a grave site within 0.5 m of well	Microbes	Sub-surface entry (unlined well)	5	4	20
Ponding of wellhead area	Absence of apron and drainage	Microbes	Sub-surface entry	5	2	10
Algae growth within and outside un-cemented well head	Exposure to the atmosphere due to partial covering and constant contact with water	Chemical	Direct contact	5	2	10
						80

21. General information

Well Name: KMT 1, Group 5
Location: Block 11, Area A, Kemta Housing Estate, Abeokuta
Dates of visits: 24/04/07; 22/05/07; 19/06/07; 19/07/07
Owner's residence status: Non-resident
Approximate Number of Users: 19 residential users
No. of Respondents: 4
Water use: Cooking, bathing, toileting and laundry
Local drinking-water supply: Tap water and pure water

Well description

Date of construction: Not available
Well depth: 14.5 m
Static water level: 8.5 m (19/07/07)
Distance to soak away pit: 13.6 m
Distance to burial site: None
Well lining: Ring lining
Well cover: Detached
Well apron: Present
Operation: Multiple buckets
Total coliform count (mpn/100ml): 2,500 & 55,000 (min & max values of 4 sampling times)

Residential users' responses:

There is no consensus between residential users on the management and monitoring of well. They however claimed to construct and manage a 'dream well' when they become a property owner.

Risks assessment:

Hazardous events	Causes	Hazards	Pathway	Likelihood	Impact	Risk score
Ingress of contaminants (rusted particles, dust, debris, waste and storm water) directly into well	Holes in metallic well cover Pipe hole left un-blocked in wellhead Low lying wellhead (0.3 m above ground level)	Microbes Chemicals Solids	Wellhead / surface entry	5	4	20
Direct introduction of contaminants into well	Use of multiple buckets from hygienically un-ascertained sources/places Users standing on wellhead Detached cover left indiscriminately around well Hand/surface pump not installed	Microbes Solids	Surface entry	5	4	20
Insect and animals faeces/litters contaminates water	Free range birds/hens, lizards and roaches around low lying wellhead	Microbes	Surface entry	5	4	20
Plants and algae growth on well apron	Cracks and gaps on cemented apron	Chemical	Direct contact	5	2	10
						70

22. General information

Well Name: KMT 4, Group 5
Location: Kemta Housing Estate, Abeokuta
Dates of visits: 24/04/07; 25/05/07; 26/06/07; 19/07/07
Owner's residence status: Resident
Approximate Number of Users: 5 residential users
No. of Respondents: 2
Water use: Cooking, bathing, toileting and laundry
Local drinking-water supply: Pure water

Well description

Date of construction: 2006 (1 year)
Well depth: 20 m
Static water level: 10 m (19/07/07)
Distance to soak away pit: 13.6 m
Distance to burial site: None
Well lining: Ring lining
Well cover: Present
Well apron: Short diameter apron
Operation: Dedicated bucket
Total coliform count (mpn/100ml): 200 & 1,600,000 (min & max values of 4 sampling times)

Residential users' responses:

Newly constructed well but being used for building construction works as at the first author's visit. By the fourth visit however, a surface pump had been installed and four tap stands connected outside the fence for non-residential users. Respondents claimed to apply water guard at point of use and they look forward to drinking the well water once the building construction work is completed.

Risks assessment:

Hazardous events	Causes	Hazards	Pathway	Likelihood	Impact	Risk score
Direct introduction of contaminants into well	Use of un-kept bucket left indiscriminately around well; Hand/surface pump not installed	Microbes Solids	Surface entry	5	4	20
Introduction of cement and masonry materials into well	Building construction activities within well area	Microbes Chemicals	Surface entry	5	4	20
Ponding of well area	Short (0.6 m) diameter apron	Microbes	Sub-surface entry	5	2	10
						50

23. General information

Well Name: OBK 3, Group 5
Location: Wale Somorin Street, Obantoko, Abeokuta
Dates of visits: 25/04/07; 25/05/07; 27/06/07; 19/07/07
Owner's residence status: Resident
Approximate Number of Users: 35 residential users + > 50 others = 85
No. of Respondents: 4
Water use: Drinking, cooking, bathing, toileting and laundry
Local drinking-water supply: Well and pure water

Well description

Date of construction: 1991 (16 years)
Well depth: 7.3 m
Static water level: 0.9 m (19/07/07)
Distance to toilet: 13 m
Distance to burial site: 4.5m
Well lining: Ring lining
Well cover: Present
Well apron: Cemented floor
Operation: Owner's buckets
Total coliform count (mpn/100ml): 1,700 & 90,000 (min & max values of 4 sampling times)

Residential users' responses:

Source owner uses the water for all household purposes including drinking; as such she monitors the well handling by especially the non-resident users and prevents the usage of multiple buckets.

Risks assessment:

Hazardous events	**Causes**	**Hazards**	**Pathway**	**Likelihood**	**Impact**	**Risk score**
Ingress of contaminants (rusted particles, dust, debris, waste and storm water) directly into well	See-through opening between damaged metallic cover and wooden plank serving as make-shift cover	Microbes Chemicals Solids	Wellhead / surface entry	5	4	20
	Gap between damaged metallic cover and wellhead					
	Wellhead flushes on one side with building fence					
Direct introduction of contaminants into well	Usage of un-kept bucket and rope left indiscriminately around well	Microbes Solids Chemicals	Surface entry	5	4	20
	Laundry activities around well area					
	Un-kept well area					
	Hand/surface pump not installed					
Percolation of human organic wastes into well	Location of a grave site 4.5 m and on higher (149 m) ground elevation to well (147 m)	Microbes	Sub-surface entry	3	4	12
Algae growth within and outside cemented well head	Exposure to the atmosphere due to partial covering and constant contact with water	Chemical	Direct contact	5	2	10
						62

24. General information

Well Name: OBK 9, Group 5
Location: Olafimihan Street, Fajol, Obantoko, Abeokuta
Dates of visits: 25/04/07; 25/05/07; 27/06/07; 19/07/07
Owner's residence status: Resident
Approximate Number of Users: 27 residential users + > 20 = 47
No. of Respondents: 4
Water use: Drinking, cooking, bathing, toileting and laundry
Local drinking-water supply: Tap water, well and pure water

Well description

Date of construction: 1996 (11 years)
Well depth: 7 m
Static water level: 3.6 m (19/07/07)
Distance to soak away pit: 13 m
Distance to burial site: None
Well lining: Ring lining
Well cover: Missing
Well apron: Present
Operation: Multiple buckets
Total coliform count (mpn/100ml): 2,000 & 13,000 (min & max values of 4 sampling times)

Residential users' responses:

Residential users find the source owner un-co-operative about the administration of the well, especially where it regards control of non-resident users.

Risks assessment:

Hazardous events	Causes	Hazards	Pathway	Likelihood	Impact	Risk score
Ingress of contaminants (rusted particles, dust, debris, waste and storm water) directly into well	Open well due to missing cover	Microbes Chemicals Solids	Wellhead / surface entry	5	4	20
Direct introduction of contaminants into well	Usage of un-kept bucket and rope left indiscriminately around well Usage of multiple buckets from hygienically un-ascertained sources/places Laundry activities around well area Hand/surface pump not installed	Microbes Solids Chemicals	Surface entry	5	4	20
						40

25. General information

Well Name: OBK 11, Group 5
Location: 2, Ben Ogundele Close, Fajol, Obantoko, Abeokuta
Dates of visits: 25/04/07; 25/05/07; 27/06/07; 19/07/07
Owner's residence status: Non-Resident
Approximate Number of Users: 2 residential users
No. of Respondents: 1
Water use: Household cleaning and livestock
Local drinking-water supply: Neighbour's well

Well description

Date of construction: 2006 (2 years)
Well depth: 4 m
Static water level: 3.6 m (19/07/07)
Distance to toilet: None
Distance to burial site: None
Well lining: No lining
Well cover: Present
Well apron: No apron
Operation: Multiple buckets
Total coliform count (mpn/100ml): 4,500 & 25,000 (min & max values of 4 sampling times)

Residential users' responses:

The property is under construction. The residents claimed the owner will re-visit the improvement of the source once the building construction is completed. The residents for now depends largely on neighbour's well.

Risks assessment:

Hazardous events	Causes	Hazards	Pathway	Likelihood	Impact	Risk score
Ingress of contaminants (rusted particles, dust, debris, waste and storm water) directly into well	Holes and gaps on rusted iron sheet well cover	Microbes Chemicals Solids	Wellhead / surface entry	5	4	20
Direct introduction of contaminants into well	Usage of multiple buckets from hygienically un-ascertained sources/places Hand/surface pump not installed	Microbes Solids	Surface entry	5	4	20
Algae growth on and plants and around wellhead	Absence of apron and flooring	Chemical	Direct contact	5	2	10
Elevated turbidity	Absence of lining	Microbes Colour Solids	Direct contact	5	2	10
Ponding of well area	Missing apron and flooring	Microbes	Sub-surface entry (un-lined well)	3	2	6
Animal faeces/litters contamination	Livestock (chickens) keeping 4.5 m from well area	Microbes	Surface entry	3	4	12
						78

A6.2: Qualitative risks assessment and description of 16 self supply wells, field visit 2008

1. General information

Well Name:	NWD 1, Group 1, Class 3
Location:	Ijeun-Titun Road, Nawarudeen, Abeokuta
Dates of visits:	28/07/08, 05/08/08, 20/08/08
Owner's residence status:	Non-resident
Approximate Number of Users:	70 (RU & NRU)
No. of Respondents:	1
Water use:	Cooking (conditional), bathing & toileting (with disinfectant), and laundry
Local drinking-water supply:	Tap water, 'Pure water'

Well description

Date of construction:	Not obtained
Well depth:	1.8 m
Static water level:	0.9 m (28/07/08)
Distance to pit latrine:	7.3 m
Distance to burial site:	2.4 & 3.6 m
Well lining:	Un-cemented block lining
Well cover:	Missing
Well apron:	Missing
Operation:	Multiple well buckets
Nitrates concentrations (mg/l):	68 & 134 (min & max values of 3 sampling times)

Residential users' responses:

'*I don't drink the water at all; the surrounding is too dirty to drink the water. I even have to add disinfectant to the water to use it for toileting because the usage had caused my son skin infection in the past. Non-resident users however come around to fetch water from the well. I know some of them cook with the water especially party food when the public tap is not running*'.

Risk s assessment:

Hazardous events	**Causes**	**Hazards**	**Pathway**	**Likelihood**	**Impact**	**Risk score**
Ingress of contaminants (rusted particles, dust, debris, waste and storm water) directly into well	Missing well cover Metallic well cover frame attached to well surface	Microbes and chemicals (Fe)	Wellhead / surface entry	5	4	20
Direct introduction of contaminants into well	Use of un-kept bucket and rope left indiscriminately around well Use of multiple buckets from hygienically un-ascertained sources/places Hand/surface pump not installed	Microbes Solids	Surface entry	5	4	20
Percolation of waste water into well	Lined public drain 2.1 m from well conveying untreated waste water	Microbes, chemicals	Sub-surface entry	3	4	12
Splashing of waste water into well	Users throwing of waste water around well head and into drain 2.1 m from well, and conveying untreated waste water	Untreated waste (microbes, chemicals)	Surface entry	5	2	10
Ponding of wellhead area	Absence of apron, flooring and drainage Un-kept well area allowing water retained under debris	Microbes	Sub-surface entry	5	2	10
Plant and algae growth within un-cemented block lining	Constant exposure to moisture and sunlight Missing well cover	Chemical	Direct contact	5	2	10
Percolation of faecal contamination into well	Location of pit latrine 7.3 m from well	Microbes	Sub-surface entry	4	4	16
Percolation of human organic wastes into well	Location of 2 grave sites within 2.4 m and 3.6 m of well point	Microbes	Sub-surface entry	4	4	16
						114

2. General information

Well Name: AGI 1, Group 1, Class 2
Location: Ago-Ijesha Road, Abeokuta
Dates of visits: 28/07/08, 05/08/08, 20/08/08
Owner's residence status: Resident
Approximate Number of Users: 100 (RU & NRU)
No. of Respondents: 1
Water use: Cooking, bathing, laundry and toileting
Local drinking-water supply: Tap water, 'Pure water'

Well description

Date of construction: Not obtained
Well depth: 2.7 m
Static water level: 1.5 m (28/07/08)
Distance to pit latrine: 24 m
Distance to burial site: None
Well lining: Cemented block lining
Well cover: Partial
Well apron: Missing
Operation: Dedicated bucket
Nitrates concentrations (mg/l): 40 & 62 (min & max values of 3 sampling times)

Residential users' responses:

The well cover was spoilt by the rains. Children are not allowed to prevent dirt in the water.

Risks assessment:

Hazardous events	Causes	Hazards	Pathway	Likelihood	Impact	Risk score
Ingress of contaminants (rusted particles, dust, debris, waste and storm water) directly into well	Partially covered well	Microbes Solids	Wellhead / surface entry	5	4	20
Direct introduction of contaminants into well	Usage of dedicated bucket and rope left on well Hand/surface pump not installed	Microbes	Surface entry	5	2	10
Algae growth on cemented well wall and lining	Constant exposure to moisture and sunlight Partially covered well	Chemical	Direct contact	5	2	10
Ponding of well area	Missing apron, flooring and drainage	Microbes	Sub-surface entry	5	2	10
						50

3. General information

Well Name: OKE 1, Group 1, Class 1
Location: Oke-Ejigbo Road, Abeokuta
Dates of visits: 28/07/08, 05/08/08, 20/08/08
Owner's residence status: Resident
Approximate Number of Users: 100 (RU & NRU)
No. of Respondent: 1
Water use: Cooking, bathing, and laundry
Local drinking-water supply: Tap water, 'Pure water'

Well description

Date of construction: Jan 2008 (7 months)
Well depth: 10 m
Static water level: 2.9 m (28/07/08)
Distance to pit latrine: 13 m
Distance to burial site: 10.7 m
Well lining: Ring lining
Well cover: Present
Well apron: Present
Operation: Multiple buckets
Nitrates concentrations (mg/l): 50 & 89 (min & max values of 3 sampling times)

Residential users' responses:

'*The well water is clean and good to taste, we however do not drink it because we are afraid of diarrheal or cholera*'.

Risks assessment:

Hazardous events	Causes	Hazards	Pathway	Likelihood	Impact	Risk score
Direct introduction of contaminants into well	Use of multiple buckets from hygienically un-ascertained sources/places	Microbes	Surface entry	5	2	10
	Hand/surface pump not installed					
	Laundry activities around well area					
Percolation of faecal contamination into well	Location of pit latrine 13 m away from well	Microbes	Sub-surface entry	2	4	8
Percolation of human organic wastes into well	Location of a grave site 10.7 m from well	Microbes	Sub-surface entry	2	4	8
Algae growth on cemented well wall	Constant exposure to moisture and sunlight	Chemical	Direct contact	5	2	10
						36

4. General information

Well Name:	KUT1, Group 2, Class 3
Location:	Isale-Oja Road, Kuto Market, Abeokuta
Dates of visits:	28/07/08, 05/08/08, 20/08/08
Owner's residence status:	Not obtained
Approximate Number of Users:	12 resident users + 5 NRU = 17
No. of Respondent:	1
Water use:	Cooking, bathing, laundry and toileting
Local drinking-water supply:	Tap water, 'Pure water'

Well description

Date of construction:	1988 (20 years)
Well depth:	6.4 m
Static water level:	2.7 m (28/07/08)
Distance to pit latrine:	17 m
Distance to burial site:	None
Well lining:	Cement lining
Well cover:	Present
Well apron:	Missing
Operation:	Multiple buckets
Nitrates concentrations (mg/l):	85 & 137 (min & max values of 3 sampling times)

Residential users' responses:

'*Anyone is allowed to fetch water from the well because water is a natural resource, but during the dry season when the water level is low, we prioritise the resident users*'.

Risks assessment:

Hazardous events	Causes	Hazards	Pathway	Likelihood	Impact	Risk score
Ingress of contaminants (rusted particles, dust, waste and storm water) directly into well	No-seal proof and see-through gaps in wooden cover and un-cemented block well head	Microbes, and solids	Wellhead / surface entry	5	4	20
Direct introduction of contaminants into well	Usage of un-kept bucket and rope left indiscriminately around well Usage of multiple buckets from hygienically un-ascertained sources/places Hand/surface pump not installed	Microbes Solids	Surface entry	5	4	20
Ponding of well area	Missing apron, flooring and drainage Laundry activities around well area Wood logs kept within well area Un-kept well area	Microbes	Sub-surface entry	5	2	10
Percolation of faecal contamination into well	Location of pit latrine 17 m from well	Microbes	Sub-surface entry	1	4	4
Algae growth within and outside well head	Exposure of well head to moisture and sunlight due to large holes and gaps in un-cemented block and wooden well cover	Microbes	Direct contact	5	2	10
						64

5. General information

Well Name:	KUT2, Group 2, Class 2
Location:	Oke-Ejigbo Road, Abeokuta
Dates of visits:	28/07/08, 05/08/08, 20/08/08
Owner's residence status:	Resident
Approximate Number of Users:	10 resident users + 50 NRU = 60
No. of Respondent:	1
Water use:	Bathing, laundry and toileting
Local drinking-water supply:	Tap water, 'Pure water'

Well description

Date of construction:	1983 (25 years)
Well depth:	6.4 m
Static water level:	1.8 m (28/07/08)
Distance to soak away pit:	14.2 m
Distance to burial site:	None
Well lining:	Ring lining
Well cover:	Present
Well apron:	Present
Operation:	Multiple buckets
Nitrates concentrations (mg/l):	153 & 410 (min & max values of 3 sampling times)

Residential users' responses:

'*We do not drink well water because the water has taste and we are afraid of cholera*'.

Risks assessment:

Hazardous events	**Causes**	**Hazards**	**Pathway**	**Likelihood**	**Impact**	**Risk score**
Ingress of contaminants (rusted particles, waste and storm water) directly into well	Perforations in metallic well cover	Microbes chemicals	Wellhead / surface entry	5	2	10
Direct introduction of contaminants into well	Usage of un-kept bucket and rope left indiscriminately around well	Microbes Solids	Surface entry	5	4	20
	Usage of multiple buckets from hygienically un-ascertained sources/places					
	Un-kept well area					
	Hand/surface pump not installed					
Insects (Cock roaches) in numbers located within well head	Moist and dark well head interior	Microbes	Direct contact	5	4	20
Percolation of faecal contamination into well	Location of soak away pit 14 m from well	Microbes	Sub-surface entry	2	4	8
Pool of waste water in cracks and holes on cemented floor	Laundry and cooking activities within well area	Microbes Chemicals	Sub-surface entry	5	2	10
	Missing drainage					
						68

6. General information

Well Name:	OMD 6, Group 2, Class 1
Location:	Omida Market, Ibara Road, Abeokuta
Dates of visits:	25/07/08, 06/08/08, 19/08/08
Owner's residence status:	Youth Forum Association
Approximate Number of Users:	200 users
No. of Respondent:	1
Water use:	Cooking, bathing, laundry and toileting
Local drinking-water supply:	Tap water

Well description

Date of construction:	2004 (4 years)
Well depth:	10.9 m
Static water level:	2.4 m (25/07/08)
Distance to soak away pit:	2.8 m
Distance to burial site:	None
Well lining:	Ring lining
Well cover:	Present
Well apron:	Present
Operation:	Multiple buckets
Nitrates concentrations (mg/l):	115 & 148 (min & max values of 3 sampling times)

Residential users' responses:

'*The water is drinkable; I drank it during the hand dug well water commissioning. The Association constructed it for communal use*'.

Risks assessment:

Hazardous events	**Causes**	**Hazards**	**Pathway**	**Likelihood**	**Impact**	**Risk score**
Ingress of contaminants (rusted particles) directly into well	Rusted metallic cover trimmings Large number of users pulling or dragging rope along metallic trimmings	Chemicals	Wellhead / surface entry	5	2	10
Direct introduction of contaminants into well	Usage of multiple buckets from hygienically un-ascertained sources/places Hand/surface pump not installed	Microbes Solids	Surface entry	5	4	20
Percolation of faecal contaminants into well	Soak away pit located 2.8 m from well	Microbes	Sub-surface entry	2	4	8
						38

7. General information

Well Name:	LNT 3, Group 3, Class 3
Location:	Adekunle Street, Lantoro, Abeokuta
Dates of visits:	28/07/08, 05/08/08, 20/08/08
Owner's residence status:	Resident
Approximate Number of Users:	17 resident users + free for all
No. of Respondent:	1
Water use:	Drinking, cooking, bathing, laundry and toileting
Local drinking-water supply:	Tap water

Well description

Date of construction:	1993 (15 years)
Well depth:	Not obtained
Static water level:	2 m (28/07/08)
Distance to soak away pit:	26 m
Distance to burial site:	None
Well lining:	Un-cemented block lining
Well cover:	Missing
Well apron:	Present
Operation:	Multiple buckets
Nitrates concentrations (mg/l):	4.4 & 6.8 (min & max values of 3 sampling times)

Residential users' responses:

'*The only way we take care of the well is by covering it and re-digging whenever the depth is shallow…..we know the normal well depth, through the process of loose bucket recovery, we will know whether the well is shallow and needs re-digging*'.

Risks assessment:

Hazardous events	Causes	Hazards	Pathway	Likelihood	Impact	Risk score
Ingress of contaminants (rusted particles, debris, dust, waste and storm water) directly into well	Missing well cover and exposed metallic well mouth frame	Microbes chemicals	Wellhead / surface entry	5	2	10
Direct introduction of contaminants into well	Usage of un-kept bucket and rope left indiscriminately around well	Microbes Solids	Surface entry	5	4	20
	Usage of multiple buckets from hygienically un-ascertained sources/places					
	Hand/surface pump not installed					
Ingress of storm water into well	Damaged wooden well cover left on well head acting as conduit for storm water from property fence into well	Microbes	Surface entry	5	4	20
Percolation of waste water into well	Lined public drain conveying untreated waste water located 1.2 m from well	Microbes, chemicals	Sub-surface entry	3	4	12
Algae growth on un-cemented block lining	Exposure to moist and sunlight	Microbes, chemicals	Direct contact	5	2	10
	Missing cover					
Pool of waste water in cracks and holes on cemented floor	Missing drainage	Microbes Chemicals	Sub-surface entry	5	2	10
						82

8. General information

Well Name: LNT 4, Group 3, Class 2
Location: Ogunbona Street, Lantoro, Abeokuta
Dates of visits: 28/07/08, 05/08/08, 20/08/08
Owner's residence status: Resident
Approximate Number of Users: 20
No. of Respondent: 2
Water use: Conditional drinking, cooking, dish washing, bathing, laundry and toileting
Local drinking-water supply: Tap water

Well description

Date of construction: Not obtained
Well depth: 6.4 m
Static water level: 1.7 m (28/07/08)
Distance to soak away pit: 7.9 m
Distance to burial site: None
Well lining: Ring lining
Well cover: Partial
Well apron: Present
Operation: Multiple buckets
Nitrates concentrations (mg/l): 36 & 77 (min & max values of 3 sampling times)

Residential users' responses:

'*In the absence of tap water, we drink the well water after adding alum or water guard….all the users are rightful users because the well owner dug it for public use*'.

Risks assessment:

Hazardous events	Causes	Hazards	Pathway	Likelihood	Impact	Risk score
Ingress of contaminants (rusted particles, dust, debris, waste and storm water) directly into well	Partially covered well	Microbes, solids, chemicals	Wellhead / surface entry	5	2	10
Direct introduction of contaminants into well	Usage of multiple buckets from hygienically un-ascertained sources/places Hand/surface pump not installed	Microbes Solids	Surface entry	5	4	20
Percolation of faecal contaminants into well	Soak away pit located 7.9 m from well	Microbes	Sub-surface entry	3	4	12
						42

9. General information

Well Name: LNT 5, Group 3, Class 1
Location: Ogunbona Street, Lantoro, Abeokuta
Dates of visits: 28/07/08, 05/08/08, 20/08/08
Owner's residence status: Resident
Approximate Number of Users: 15 resident users + 20 = 35
No. of Respondent: 1
Water use: Drinking, cooking, dish washing, bathing, laundry and toileting
Local drinking-water supply: Tap water

Well description

Date of construction: 1978 (30 years)
Well depth: 4.5 m
Static water level: 2.4 m (28/07/08)
Distance to soak away pit: 10 m
Distance to burial site: 2.7 m
Well lining: Ring lining
Well cover: Present
Well apron: Present
Operation: Multiple buckets
Nitrates concentrations (mg/l): 6 & 39 (min & max values of 3 sampling times)

Residential users' responses:

'*The well water is very good, I use it for everything I need water for and I don't go after tap water*'.

Risks assessment:

Hazardous events	**Causes**	**Hazards**	**Pathway**	**Likelihood**	**Impact**	**Risk score**
Ingress of contaminants (rusted particles and storm water) directly into well	Gaps between wellhead and metallic cover	Microbes, chemicals	Wellhead / surface entry	2	2	4
Direct introduction of contaminants into well	Usage of multiple buckets from hygienically un-ascertained sources/places Hand/surface pump not installed	Microbes Solids	Surface entry	5	4	20
Percolation of faecal contaminants into well	Soak away pit located 10 m from well	Microbes	Sub-surface entry	2	4	8
Percolation of human organic wastes into well	Location of a grave site 2.7 m from well	Microbes	Sub-surface entry	4	4	16
Ponding of well head area	Missing apron, flooring and drainage Laundry and dish washing activities by the well head	Microbes	Sub-surface entry	5	2	10
						58

10. General information

Well Name:	ODO 1, Group 4, Class 3
Location:	Odo-Oyo, Itoku, Abeokuta
Dates of visits:	23/07/08, 06/08/08, 21/08/08
Owner's residence status:	Deceased
Approximate Number of Users:	100
No. of Respondent:	1
Water use:	Cooking, bathing, laundry and tie & dye business
Local drinking-water supply:	Tap water

Well description

Date of construction:	1968 (40 years)
Well depth:	0.9 m
Static water level:	0.3 m (23/07/08)
Distance to pit latrine:	1.5 m
Distance to burial site:	5.2 m
Well lining:	Un-cemented block lining
Well cover:	Missing
Well apron:	Missing
Operation:	Multiple buckets
Nitrates concentrations (mg/l):	75 & 98 (min & max values of 3 sampling times)

Residential users' responses:

'*The well is very prolific; never dries up! Some non-resident users do come to beg for water but the owner in charge sells the well water for the people using it for tie and dye business*'.

Risks assessment:

Hazardous events	Causes	Hazards	Pathway	Likelihood	Impact	Risk score
Ingress of contaminants (rusted particles, dust, debris, waste and storm water) directly into well	Un-covered well Low-level well head (0.5 m from ground surface)	Microbes, solids, chemicals	Wellhead / surface entry	5	4	20
Direct introduction of contaminants into well	Usage of un-kept bucket and rope left indiscriminately around well Usage of multiple buckets from hygienically un-ascertained sources/places Usage of buckets used for tie & dye work Hand/surface pump not installed	Microbes, Solids, chemicals	Surface entry	5	4	20
Percolation of faecal contaminants into well	Soak away pit located 10 m from well	Microbes	Sub-surface entry	5	4	20
Percolation of human organic wastes into well	Location of a grave site 5.2 m from well	Microbes	Sub-surface entry	5	4	20
Animal waste in water	Living fish inside well	Microbes	Direct contact	5	3	15
Algae growth within and outside well head, and lining	Exposure to moist and sunlight Missing cover	Microbes, chemicals	Direct contact	5	3	15
Ponding of well head area	Missing apron, flooring and drainage Bathing, laundry and toileting activities by the well head	Microbes	Sub-surface entry	5	4	20
						130

11. General information

Well Name:	IDA 1, Group 4, Class 2
Location:	Isale-Ijeun, Idi-Ape, Itoku, Abeokuta
Dates of visits:	25/07/08, 06/08/08, 21/08/08
Owner's residence status:	Deceased
Approximate Number of Users:	100
No. of Respondent:	1
Water use:	Bathing and laundry
Local drinking-water supply:	Tap water and 'pure water'

Well description

Date of construction:	1988 (20 years)
Well depth:	2.5 m
Static water level:	2 m (25/07/08)
Distance to pit latrine:	None
Distance to burial site:	0.1 - 5 m
Well lining:	Cemented wall lining
Well cover:	Present
Well apron:	Missing
Operation:	Multiple buckets
Nitrates concentrations (mg/l):	79 & 117 (min & max values of 3 sampling times)

Residential users' responses:

Well operation time is 7 am to 5 pm…..the elders says that '*it is dangerous to fetch water at night*'. The saying is tied to a local mirth; '*the household that allows water fetching at night will be scattered*'.

Risks assessment:

Hazardous events	**Causes**	**Hazards**	**Pathway**	**Likelihood**	**Impact**	**Risk score**
Ingress of contaminants (rusted particles, dust, debris, waste and storm water) directly into well	No-seal proof and see-through gaps on wooden cover, and between cover and well head	Microbes, Chemicals and solids	Wellhead / surface entry	5	4	20
	Rusted iron sheets as part well cover					
Direct introduction of contaminants into well	Usage of un-kept bucket and rope left indiscriminately around well	Microbes, Solids, chemicals	Surface entry	5	4	20
	Usage of multiple buckets from hygienically un-ascertained sources/places					
	Usage of buckets used for tie & dye work					
	Hand/surface pump not installed					
Percolation of human organic wastes into well	Nine grave sites within 0 – 5.2 m of well, 3 of which formed boundary with well	Microbes	Sub-surface entry	5	4	20
Algae growth on wooden well cover	Exposure to moist and sunlight	Microbes, chemicals	Direct contact	5	2	10
Percolation of waste water to well	Lined public drain conveying un-treated waste water located 2.1 m from well	Microbes, chemicals	Sub-surface entry	2	4	8
Ponding of well head area	Missing apron, flooring and drainage	Microbes	Sub-surface entry	5	2	10
Elevated turbidity	Large cracks in cemented wall lining	Microbes Turbidity Colour	Direct contact	5	2	10
						98

12. General information

Well Name:	ITK 12, Group 4, Class 1
Location:	Mama’s house, Ifote-Itoku, Abeokuta
Dates of visits:	25/07/08, 06/08/08, 21/08/08
Owner’s residence status:	Resident
Approximate Number of Users:	100
No. of Respondent:	1
Water use:	Drinking, cooking, bathing and laundry
Local drinking-water supply:	Tap water

Well description

Date of construction:	1990 (18 years)
Well depth:	1.8 m
Static water level:	0.9 m (25/07/08)
Distance to pit latrine:	24.4 m
Distance to burial site:	None
Well lining:	Cemented block lining
Well cover:	Present
Well apron:	Present
Operation:	Dedicated bucket
Nitrates concentrations (mg/l):	94 & 112 (min & max values of 3 sampling times)

Residential users’ responses:

An owner managed and monitored well. Monitoring is by personal supervision and key collection and return style. The well owner felt slighted being asked what she uses her well water for. She claimed that the government had no right to interrogate her on the usage of her well since they failed to provide her with water.

Risks assessment:

Hazardous events	**Causes**	**Hazards**	**Pathway**	**Likelihood**	**Impact**	**Risk score**
Ingress of contaminants (rusted particles, dust, debris, waste and storm water) directly into well	No-seal proof and see-through gaps in rusted iron sheet and wood cover, and between cover and well head	Microbes, Chemicals and solids	Wellhead / surface entry	5	4	20
	Tyres on well to keep well cover in place					
Direct introduction of contaminants into well	Usage of un-kept bucket and rope	Microbes, solids, chemicals	Surface entry	5	4	20
	Hand/surface pump not installed					
Percolation of waste water to well	Lined public drain conveying un-treated waste water located 2.5 m from well	Microbes, chemicals	Sub-surface entry	2	4	8
						48

13. General information

Well Name: ONKK 1, Group 5, Class 3
Location: 8, Oyewole-oyebola Street, Lipede Estate, Onikoko, Abeokuta
Dates of visits: 23/07/08, 09/08/08, 19/08/08
Owner's residence status: Non-resident
Approximate Number of Users: 14 resident users
No. of Respondent: 1
Water use: Conditional cooking, dish washing, laundry and toileting
Local drinking-water supply: Tap water

Well description

Date of construction: 2005 (3 years)
Well depth: 4.5 m
Static water level: 2.3 m (23/07/08)
Distance to soak away pit: 39.7 m
Distance to burial site: None
Well lining: Ring lining
Well cover: Present
Well apron: Partial
Operation: Multiple buckets
Nitrates concentrations (mg/l): 9 & 93 (min & max values of 3 sampling times)

Residential users' responses:

'*I believe well water is not so clean because it is not treated and I prefer even rainwater to tap water because rainwater is lighter* (to taste)'.

Risks assessment:

Hazardous events	Causes	Hazards	Pathway	Likelihood	Impact	Risk score
Direct introduction of contaminants into well	Usage of un-kept bucket and rope Usage of multiple buckets from hygienically un-ascertained places Hand/surface pump not installed	Microbes, solids	Surface entry	5	2	10
Ponding of well head area	Missing drainage Partial well apron and flooring Grass land beside well head	Microbes	Sub-surface entry	2	4	8
Elevated turbidity	Low water level	Turbidity Colour	Direct contact	5	2	10
						28

14. General information

Well Name: ADG 12, Group 5, Class 2
Location: Oderinde Street, Adigbe, Abeokuta
Dates of visits: 23/07/08, 06/08/08, 19/08/08
Owner's residence status: Non-resident
Approximate Number of Users: 40 resident users
No. of Respondent: 1
Water use: Cooking, dish washing, bathing and laundry
Local drinking-water supply: Tap water and 'pure water'

Well description

Date of construction: 2005 (3 years)
Well depth: 7.3 m
Static water level: 3.6 m (23/07/08)
Distance to soak away pit: 17.4 m
Distance to burial site: None
Well lining: Ring lining
Well cover: Present
Well apron: Missing
Operation: Multiple buckets
Nitrates concentrations (mg/l): 37 & 60 (min & max values of 3 sampling times)

Residential users' responses:

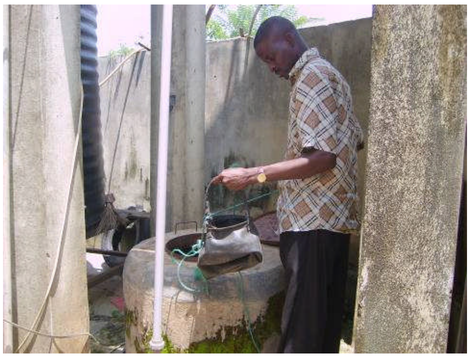
'I believe well water is not so clean because it is not treated and I prefer even rainwater to tap water because rainwater is lighter (to taste)'.

Risks assessment:

Hazardous events	**Causes**	**Hazards**	**Pathway**	**Likelihood**	**Impact**	**Risk score**
Direct introduction of contaminants into well	Usage of un-kept bucket and rope Usage of multiple buckets from hygienically un-ascertained places Hand/surface pump not installed	Microbes, solids	Surface entry	5	4	20
Percolation of faecal contamination into well	Soak away pit located 17.4 m from well	Microbes	Sub-surface entry	1	4	4
Ponding of well head area	Missing well head apron, flooring and drainage	Microbes	Sub-surface entry	2	4	8
						32

15. General information

Well Name:	ONK 1, Group 5, Class 1
Location:	Pastor Bayo's residence, Onikolobo, Abeokuta
Dates of visits:	23/07/08, 06/08/08, 19/08/08
Owner's residence status:	Non-resident
Approximate Number of Users:	19 resident users
No. of Respondent:	1
Water use:	Cooking, dish washing, bathing, laundry and toileting
Local drinking-water supply:	Tap water



Well description

Date of construction:	1999 (9 years)
Well depth:	19.1 m
Static water level:	12 m (23/07/08)
Distance to soak away pit:	8.2 m
Distance to burial site:	None
Well lining:	Ring lining
Well cover:	Present
Well apron:	Present
Operation:	Dedicated motorised pump
Nitrates concentrations (mg/l):	12 & 19 (min & max values of 3 sampling times)

Residential users' responses:

'*We use the water for 'all, except drinking…' The water is ok, but the tank is usually dirty. We do not get around washing the tank often. Sometimes it takes 3 to 4 months interval and once a while, greenish particles come with the water….*'

Risks assessment:

Hazardous events	Causes	Hazards	Pathway	Likelihood	Impact	Risk score
Percolation of faecal contamination into well	Soak away pit located 8.2 m from well	Microbes	Sub-surface entry	2	4	8
Algae growth in well water tank	Water tank left un-washed for long	Microbes	Direct contact	5	4	20
Elevated turbidity	Sediments in water tank Un-washed water tank	Microbes Turbidity Colour	Direct contact	4	2	8
						36

Remark: The only access to the well water is through the water tank. On one of the visits, water sample was collected just after pumping. The water turbidity was 17 FTU as against 6 FTU previous, corroborating the respondent's claim that the water tank is usually left un-washed for so long.

16. General information

Well Name:	KMT 6, Group 5, Class 1
Location:	Block 5, Plot 12, Kemta Housing Estate, Ajebo Road, Abeokuta
Dates of visits:	25/07/08, 06/08/08, 21/08/08
Owner's residence status:	Resident
Approximate Number of Users:	10 resident users
No. of Respondent:	1
Water use:	Cooking, dish washing, bathing, and laundry
Local drinking-water supply:	Tap water and 'pure water'

Well description

Date of construction:	1988 (20 years)
Well depth:	5.5 m
Static water level:	3 m (25/07/08)
Distance to soak away pit:	33.5 m
Distance to burial site:	None
Well lining:	Ring lining
Well cover:	Present
Well apron:	Present
Operation:	Dedicated bucket
Nitrates concentrations (mg/l):	14 & 34 (min & max values of 3 sampling times)

Residential users' responses:

'*It is a self-decision not to drink well water because we know the water is not pure unless it is boiled*'.

Risks assessment:

Hazardous events	**Causes**	**Hazards**	**Pathway**	**Likelihood**	**Impact**	**Risk score**
Direct introduction of contaminants into well	Usage of un-kept bucket and rope	Microbes, solids	Surface entry	5	2	10
	Hand or surface pump not installed					
						10

A5.2: Respondents Interviews in order of Well locations

Sample number: AMLS 1
Well location: No 4, Ariyanja Street, Amolasho, Kuto, Abeokuta
Dates: 21/05/2007; 16/07/07

Respondents' profile:

R1
Sex: Female
Age: 45 years
Occupation: Teaching
Formal Education level: Secondary
Well ownership status: Resident user

R2
Sex: Female
Age: 39 years
Occupation: Trading
Formal Education level: Primary
Well ownership status: Resident user

Interviews:

I: I want to take some of the water you have stored inside.
R_1: We don't store water inside again.
I. Why is it?
R_1: We fetch and use; rain has started and tap also is regular now
I: So no one has the water at home
R_2: No
I: The last time I came rain has not started, and we thought may be it is the absence of rain that caused the presence of germs and then I said I will come after the start of rains. I also said that I will come back to give you the result. Now that the water has germs what do you think you can do to make the water safe?
R_1: Is it to this well?
I: Yes, to make the well safe for use
R_1: We don't know what can be done but you should know what to do to make it safe or may be we should tell the children that are fetching the water not to put their drawer on the floor or bare ground again.
R_2: You have checked it with an instrument and discovered that there is germ there. We don't see anything in it as we are looking now. But if there is something to be done to remove the germs or if you have any advice, tell us.
I. If government sends sanitary inspectors to inspect your well will you allow them?
R_1: We would allow them; after all we are here listening to you now.
I: What I am saying is being the owner of the well………….
R_2: Are you saying that if the government should lock the well up?
I: May be or they may advice you on things to do to make the well better for use.
R_2: When we don't have public tap, the government didn't do anything to that and they want to close our well?
I: I am not saying that government will ask you to lock up your well. If the government get involved in the care of our water wells and offer to assist in any way will you resist or accept their initiatives?
R_1: You know that tap water is government's responsibility and this has not gone round and we can not keep waiting for them to come because people use water everyday. That's why we are all turning to use well water. Our concern is that government should help us to monitor wells so that they don't become source of disease unto us. Do you understand it?
I: Assuming we now advise the government that the well owners and users cannot monitor their wells or do not know whether there are germs there or not. If it now happens that there is something the government can do or make a policy that if you take certain steps your well will be free of germs, will you accept such steps from government?
R_1: That depends on the landlord, we are tenants here and the landlord can eject us at any time and if we take action without informing him (Landlord) it could be another problem.
I: But you are the one using the well and not the landlord?

R_2: The landlord will not want to know that.
I: If the water gives you health problem will you go to your landlord to collect money to treat yourself?
R_1: Tell us if there is anything we can do, if it were something we can do we would do it and if there are anything to take away from the suggestions we would remove it.
I: So you are saying if we give you any advice now you will follow it?
R_1: Yes.
I: Ok, let's see. I will like to see changes in my next two visits and the way I can see changes is that I will collect the sample then and compare it with what we have now. I can see that there is no protection for the well. What we call protection about well is well lining, there is no lining here. It would be better if you can provide such protection. Another thing is that we can have a concrete floor round the well, and the cover will not have holes like this. Thirdly this is about the users. It will be better to tie a drawer (bucket) to the cover and keep it inside the well every time.
R_1: It is not that we cannot tie a drawer to the well but the people around here are destroyers; they are destructive. It is good as you said it but if we tie one there they will use it badly, and they have their own drawer.
I: And you cannot lock the well and allow only those who are ready to use it the way you want?
R_1: We have done it before, even the landlord instructed us to be locking it then but the bad word from people prevented us from locking it further
I: But now you know that you have to do something for health safety.
R_2: They said, 'you are tenants when you are ejected carry the well along with you' those are there words.
I: Can the landlord not give the order?
R_1: He gave it and when we took action based on what he said and the people rebelled, he still shifted the blame on us. He said did we rent the house because of water?
I: But now that it has become a health hazard or can cause infection
R_1: God will not allow such to happen, we will never see sickness.
I: That is our prayers too, but you know that it will be difficult for you to give water that you know can cause harm to people who come to ask you for water. You know that your child cannot ask for water from you and you give him one that will harm him.
R_2: If I have harmful water in my water pot I will throw it away and fetch another.
I: Do you see my point, it is not a matter of not wanting to assist people with water but to make sure that people who use this well adhere to what will make it safe for everybody.
R_1: This neighbourhood is terrible it is a school and within a year of living here I have learnt lessons of life.
I: Are you saying there is no way for you to protect the well because people will not allow it?
R_1: All we can do is to pray to God for his protection. What you are doing for us now is to ensure our safety. But if we ask them not to fetch it they will say the well has been there for a long time, they have been using it and nothing happened, why should government now come to say we cannot use it.
I: Okay, what can I call you?
R_1: Call me mama Ibeji.
I: How old are you?
R_1: 45 years.
I: What about you ma?
R: Ayi's mummy
I: How old are you?
R: 39 years.
I: What is your work?
R_1: Teaching.
R_2: Trading
I: Your education levels ma
R_2: Primary six
R_1: Secondary school
I: Thank you

I: Mama Ibeji, what about if there is no other water except this for your drinking

R$_1$: We may boil it. Moreover, we would have gotten used to it, after all our people are drinking such water in the villages.

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I: If you are sick what do you do?
R$_1$: Never; I've never sick
I: Never?
R$_1$: It is over 20 years
I: What about your children?
R$_1$: Once I use chloroquin and co for them and they were okay
I: Do you go to hospital when you are pregnant?
R$_1$: No, I only loose appetite for food. They've never allowed me to be admitted in hospital unless when I have to put to bed.
I: So none of you bought the water guard?
R$_1$: We are going to buy it
I: Have you been able to give our message to the landlord?
R$_1$: He doesn't come here often
I: What is his name?
R$_1$: We don't know his name beyond Aderoju
I: How many people are using this well?
R$_1$: They are many
I: Up to a hundred?
R$_1$: They will be more than that particularly during dry season
I: What is the name of this place?
R$_1$: No. 4, Ariyanja Street, Amolasho
I: Assuming the landlord says he is not going to do anything will the tenant do it?
R$_1$: Yes, look at the cover we (the resident users) are going to call the welder to fix it.
I: Who will pay for the repairs?
R$_1$: He is a known person; he won't collect money from us
I: What about the fixing of the well lining?
R$_1$: You can help us to do that
I: We are not the one using it and that is why we asked the question of who will pay for the repairs if the landlord refuses, will the tenant do it?
R$_1$: We can't do it we would tell the landlord; it is his house.
I: But you use the well daily
R$_1$: They don't consider that with us. We all pray to have our own houses.
I: Did people yield to your instructions on the well?
R$_1$: No they did not
I: Why, don't you lock it up?
R$_1$: We don't hoard water or keep people from the well
I: We are not saying that you should keep people away from the well; we are talking about the proper usage of the well.
R$_1$: We would do the cover
I: What about the doro (drawer) will you not tie it to the cover?
R$_1$: If it stays long in the water it will become slippery.
I: Like how many people live here?
R$_1$: We are up to ten dozen.
I: How many families?
R$_1$: Fifteen (15)
I: How many people per family
R$_1$: It varies 6, 2, 8, 4, 4, 6, 1, 1, 4, 6, 5, 6, 1, 1, 1,
I: Is that the date they dug the well?
R$_1$: Yes
I: Other people in the house what do they do when they are sick?
R$_1$: I don't know what people do in their rooms.
I: How do you know it is chloroquin that you have to use?
R$_1$: I don't use anything quin, even my children I use Fansida for them

I: How do you know that it is Fansida you should use?
R_1: That's what I have been using for them
I: What about if he has a different sickness
R_1: If I don't see changes I will take him for blood test and if he has typhoid I will take him back to hospital and when they in the hospital see the result they know what to give.
I: How many times have your children had typhoid?
R_1: It is not always typhoid, it may be malaria. Typhoid is just once.
I: Aunty what about you?
R_2: If I am sick, I drink water. I don't take injection or use drugs.
I: What about the children?
R_2: I either use paracetamol or septrin (an antibiotic) for them
I: How do you know it is Septrin that you ought to use?
R_2: Someone prescribed it for me and whenever they run temperatures (fever), I use it for them.
I: Is it paracetamol that you use every time they have high temperature?
R_2: I give them herbs too
I: How do you know the herbs to administer, I presume there are different herbs for malaria, back pain, dysentery etc?
R_2: I try to observe the symptoms
I: So you don't take them for medical check up
R_2: No
I: Thank you, do you have tap water nearby?
R_2: Yes down there
I: Would they allow me to fetch water there?
R_2: Yes.

Sample number: AMLS 2
Well location: No 16, Ariyanja Street, Amolasho, Kuto, Abeokuta
Dates: 21/05/2007; 18/06/07; 16/07/07

Respondents' profile:

R3
Sex: Male
Age: 60 years
Occupation: Welder
Formal educational level: Primary
Well ownership status: Co-owner

R4
Sex: Male
Age: 25 years
Occupation: Decorator
Formal educational level: Higher
Well ownership status: Resident user

R5
Sex: Female
Age: 80 years
Occupation: Trader
Formal educational level: None
Well ownership status: Co-owner

R6
Sex: Female
Age: 46 years
Occupation: Trader
Formal educational level: Primary
Well ownership status: Resident user

Interviews:

I: My name is Oluwasanya. We met one woman here and a boy the last time we came. The reason for our coming is the well water that people are using. We carried out some tests on the well water during our last visit and we discovered some disease-causing contaminants in the water. As owner and users what can you tell us about the possible causes of the result and also what you think you can do about it?

R_3: We've never heard of what you are saying since 1972 that we dug the well. We don't drink it we only use it for washing cloth and we have not heard of the disease you are talking about before

I: So no one had cholera here before?

R_3: Among us? Never

I: The germs found in the water causes cholera, diarrheal, etc...What about dysentery?

R_3: We would never see that here. What I want to ask is what we can use to treat the well.

I: There are different types of control but you need to make an effort first. For instance if the government decides to intervene will you allow them?

R_3: I will not accept since it doesn't belong to them. What we need to know is what can be done. As it is we use it only for washing, we don't drink it…

R_4: Sometimes we drink and cook with it

I: I can tell you some of the things that you can do

R_3: That is what we want to hear

I: A good ring lining with a cover will be good. The surroundings should be cemented with drainage to allow free flow of water. If these are what you are to do will you be willing to do them?

R_3: This entire place we can make correction all you have said is to awaken us. Now it is raining when the rain stops we shall pack all the dirt and empty the well.

I: Do you allow people to bring their doro (drawers)?

R_3: No we don't allow anyone to put just anything inside the well.

I: Instead of each person bringing different buckets is it possible to have just one tied to the cover and drop it in the well.

R_3: It is not possible because people will not want to leave their doro for others to use

R_4: That is not the issue, what makes individual to have their own doro (drawer) is that most people are careless when using it and it may drop into the well. To have one is not the problem but letting it drop off is the problem and also to damage the doro (drawer). Several like that have happened.

I: What do you think you can do then?

R_4: We would call ourselves together and make rules that everybody must use only one doro that we provide.

I: Do you think that the rule will work?
R_4: It will work, otherwise whosoever will not be allowed to use other drawer.
I: Will people obey the rules, if you are not outside and non-residents come with there doro what happens?
R_4: People from outside don't bring drawer, they borrowed from us here and if they should come now and find one there, that's the one they will use.
I: Daddy do you think that you can achieve all that we said?
R_3: Yes, but only during the dry season
I: Is it possible to get some water from the one you have stored in the house?
R_4: We don't store the water inside our homes, we use the water immediately we collect it from the well, and we use it only for washing of cloths.
I: What about the water you use for cooking, do you store it?
R_4: No, we collect and use it immediately. The only condition that could make us to store the water is if we want to work in the morning, we may collect it in the previous night and use it in the following morning.
R_3 If we collect it and allow it to settle I think it is better that way
I: Can I have some of the water from the one that you store at home then?
R_3: We don't have any at home stored unless you are going to take from the well
R_4: Bring here some water from inside.
R_3: That one was collected this morning.
I: That one is okay since you have drawn it and took it inside. This is the one that you will use for cooking if you want to cook, isn't it?
R_4: Yes
R_3: Do you use if for cooking?
R_4: Yes we use it for cooking
R_3: Well we don't drink the water
I: Thank you daddy. I will expect that we work on everything that we have talked about unless those that rain will not allow us to do. I will come again next month and collect some of the water again.
R_3: You will meet me at home if I know the time that you will be coming.
I: It will be around the second week in June, and again once in July.
R_3: Is there nothing that you can recommend to kill the germs?
I: There is, it is called water guard I will bring it next time that I am coming. The instruction on how to use it is on it, one capful for about 25 litres of water and or you have a drum of hundred litres you will apply four cap to it mix it together and leave it for about 30 minutes, afterwards it is drinkable and safe for anything. And it is not expensive I heard that precious pharmacy sells it.
R_4: What is the name?
I: Water guard.
R_4: If we want to use a small bucket like this one
I: Yes just follow the instruction on it.
R_3: Can we use it for tap water also?
I: Yes
R_4: Some well water is better than tap water, often time when we collect tap water it is rough and we have to wait for it to settle before we can use it.
I: Such chemicals are in the market but we don't know weather you are aware of it
R_3: We've never heard of it
I: There is treatment and you can be treating the water before use pending the dry season when you would be able to work on improving the state of the well.
R_3: What is the name again?
I: Water guard I will write it for you. Now that you have heard about it, is it something that you will be interested to do?
R_3: Yes, it is for our benefit
I: Next time I come I will collect the water again and compare it with the former result and if you have started using this chemical I will collect the treated water for sampling as well
R_3: I will buy it today and pour the whole thing inside the well
I: No, not in the well. It is the one you collect for use.
R_3: If I want to do both can I drop a little in my bucket of water?

I: What you can do is to treat a drum of water then you can collect water for use from the treated water in the drum
R_3: We need to ask very well because this is an important issue.
I: When I come back I will like to collect sample from your water, the one that you have treated and compare it with the last result we had.
R_3: This is our shop you will meet us here when you come.
I: Precious pharmacy is at Omida, Adatan or at Abiola way.
R_3: Are you just starting this program?
I: No we have started for some time now and it will be on till July.
I: What is your name sir?
R_3: Mr. Ayinla Salau
I: How old are you?
R_3: 60yrs
I: Your education level sir
R_3: Primary six
I: What work do you do?
R_3: Welder

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I: How many families use this well?
R_4: We are many even our neighbours also are using it; we would be up to four doz. (48)
I: How many families live in the house?
R_4: Many
I: How many both up and downstairs?
R_4: Around twelve up twelve down (24)
I: Each family comprises of about how many people?
R_4: Seven (7)
I: Is Baba around?
R_4: Yes
I: What do you do when you are sick?
R_4: I go to hospital
I: Which hospital?
R_4: General Hospital
I: What was the sickness you went to treat the last time you went to the hospital?
R_4: Malaria
I: What about your junior one
R_4: They don’t fall sick
I: Do you at any time have typhoid?
R_4: No
I: What about others in the house?
R_4: I can’t say
I: What do you use the well water for?
R_4: For all things with water guard
I: Do you treat water at home?
R_4: No
I: What can you say about treating water with water guard; comparing with tap water
R_4: There is no difference, sometimes we drink it
I: Do you know whether other people have the water guard?
R_4: Some may be hearing most people do not believe in what you are saying.
I: Baba said he is going to work on the well during the dry season, do you believe that?
R_4: I don’t think so, they have non-challant attitude
I: What is your name?
R_4: Yemi Amoo
I: What do you do?
R_4: I am a decorator

I: What are you decorating?
R_4: Interior decoration
I: What's your education qualification?
R_4: H. N.D.

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I: I was here last month………
R_5: The last time you came it may probably be a market day like this, I was not at home.
I: Daddy and some others attended to us. The last time I came, I told them that if the result shows that the water has problem I will come back and that's why I came. I also showed them this chemical. It can kill all the germs. About all the surroundings of the well, if they can plaster it with cement and they told me that they will do it during the dry season. I then told them to buy this individually and treat their water with it.
R_5: I did not hear about it at all
I: I wrote the name for them, I even showed them a sample
R_5: I never heard of it.
I: I told them how much they are selling it and where they can get it at Precious Pharmacy, Omida
R_5: How much is it?
I: It is N80.00
R_5: Even if it is N200.00
R_5: Is it that we are going to pour it inside the well?
I: No just the one you are going to use.
I: After a month I will come back again and tell you the result.
R_5: Many have died through what they eat or drink and it is not known.

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I: Mummy what do you do when you get sick?
R_5: I cook herbs for malaria
I: What about if it is not malaria?
R_5: There is nothing else except malaria
I: Typhoid is a type of malaria. It start with fever have you had it before?
R_5: No
I: What about your children?
R_5: No, we don't know typhoid here.
I: So whatever sickness you have you are saying that you only use herbs?
R_5: Yes
I: How often do you get the malaria?
R_5: Not often
I: Like how many times in a year?
R_5: Once
I: When you have malaria do you have other symptoms that are not of malaria...

I: Daddy and I talked about renovating the well
R_5: Yes we are going to do that in the dry season when the water level goes down
I: Are you saying before my next visit?
R_5: No, we would do all the plastering in the dry season
I: Why don't you put the (doro) inside the well?
R_5: Our people are hard to control but we don't allow people to bring drawer bucket from outside, they might pick it from inside the gutter and we are using the water for cooking and drinking when there is no tap water.
I: We also talked about a chemical that you can use.
R_5: I have forgotten
I: What about others, are they using it, or they forgot too?
R_5: No, they are not. May be they forgot
I: Now that I have reminded you, will you buy it?
R_5: Yes

I: What is your name?
R_5: Mrs. Shade Ogundele
I: How old are you?
R_5: Eighty

Remarks:

Respondent R6 was met on the first visit to the location. She was informed about the research and the intent to return to show the result of the water quality analysis and have an interview session with owners and users of the hand dug well. She was however absent in all subsequent visits.

Sample number: AMLS 7
Well location: Baba Eleshin's compound, Abo-Aba Road, Itori Odo, Abk
Interview dates: 21/05/07; 18/06/07; 16/07/07

Respondents' profile:

R7
Sex: Female
Age: 30 years
Occupation: Food vendor
Formal Education level: Primary
Well ownership status: Non-resident user

R8
Sex: Female
Age: 40 years
Occupation: Civil servant
Formal Education level: Primary
Well ownership status: Resident user

R9
Sex: Male
Age: 61 years
Occupation: Traditional Medics
Formal Education level: Secondary
Well ownership status: Source owner

R10
Sex: Male
Age: 42 years
Occupation: Farmer & driver
Formal Education level: None
Well ownership status: Resident user

Interviews:

I: Let's start by asking how you think the germs got into the well.
R_7: You can ask the owner, I am here to fetch water only.
I: It affects both the owner and users.
R_7: Actually you are the one who can tell us.
I: The test revealed that germs are there but you are the users so you should be able to tell us what you think is responsible for such.
R_7: Everything is for use to us we don't even see any germs or anything wrong with the water.
R_8 It is just for cloth washing and plate washing
I: You don't drink it?
R_8: Yes (meaning no) we don't, other people may be drinking it but we don't. We drink tap water.
I: Before the advent of tap water what are you drinking?
R_8: It has been only tap water since I come to Abeokuta here.
I: How many years ago is that?
R_8: It is a long time. We have tap water all around us and there is no restriction to it
I: Would it have been up to 20 years that the tap has been there?
R_8: The tap is across the road before and on the other road now. All our area is full of tap water.
I: Are you better off with the problem of looking for water here and there than improving the one that you have so close to you?
R_8: The tap is not far just across the road and the well water is for washing and bathing. It is when there is no tap water that people come here.
I: If there is no person using the well water for cooking or drinking what about when there is no tap water?
R_8: We don't drink it; we have jerry cans for storing tap water at home.
I: So all the water I see you fetch is for washing?
$R_{7:}$ Yes, but I am speaking for myself. It is only when there is no tap water that people come here.
I: So you don't know what the causes can be and because you are not drinking it you think you should not do anything?
R_8: We should, it is necessary to do something. Some other people may be drinking it, others may cook with it, others believed that all the germs in it dies when you boil the water for cooking and some they feel that what about if they are living in the village
I: Since we are using it anyway even if it is only for laundry, isn't there anything you can do to improve and make it better. What type of care do you think you can give to the well?
R_8: May be we should build a cover on it and put it under lock
I: What about cementing the floor around the well and drainage, will those be possible for you to do?
R_8: Yes it is a thing that we can do if there is a need for it.

I: Do individual has their drawer separately to draw water
R: Yes
I: Can you tell where they pick such drawer from?
R_8: In that case we are to be using one drawer. It means we would have to tie it to the well and keep it inside the well so that anyone who wants to use it will use it and leave it there again. But people must be well monitored because some people will still go ahead and use their own drawer
I: If they meet a drawer there would there be a need for anyone to use his/her own drawer again?
R_7: Two, three people can draw water at the same time if they are in haste, so if one is in haste he may be impatient to wait for his turn.
R_8: On several occasion they have broken and removed the zinc cover on the well.
I: So you are saying that there is no way that you owners can handle this people?
R_8: There is no way; some after fetching water will turn it down here on the ground and if we complain they would say that it will flow away.
I: But we are all going to benefit from it, if anyone fetches it like this; he takes home germs, so I think we should be able to control them.
R_8: We may be able to control people within the house what about the outsiders, particularly during dry season when there is no tap water, how many people are we going to talk to?
I: If we involve the government into it and they send sanitary inspectors to monitor the owners and the users will you accept such move?
R_8: How many people or wells do you want to monitor? I am a civil servant and if not that I am at home today you won't meet me at home.
I: If they decide to come when you are not at home like NEPA staff do to check every well and after their check discover that you are not taking good care of it and booked you for it and fine the whole house
R_8: What we can do is lock up the well, if we are out those that want to use it will have to wait; if they come and meet it locked they will turn back. It is difficult for such people to break the key.
I: You as a user (non-resident), would you mind such things?
R_7: No, we have tap water in our house and if we come here and meet the well locked we will come back.
I: But if you are fetching water and another comes and bring his drawer
R_7: He will have to use the only one
I: Supposing the person is in a hurry while you are fetching your own and he has another drawer with him how will you stop him from using his own drawer?
R_7: He would have to wait or else leave without fetching water.
I: That means that there are things that we can still do if we want to.
R_8: It is an agreement between the people
I: I will come back two more times and the reason is that I will want to know if we have started taking the steps we just spoke about. Secondly I will take sample of the water to see of there is an improvement in it. I will also want to know what you do and the reaction of people to it, if it's ok with you. Aunty, how old are you?
R_7: I don't live here
I: Yes but because I spoke with you. What is your child's name?
R_7: Soheeb
I: How old are you?
R_7: 30 years
I: What about your education
R_7: Primary six
I: What about you mummy?
R_8: Mrs. Solanke
I: How old are you?
R_8: 40 years
I: What is your work?
R_8: Civil servant (local government worker)

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I: Good afternoon sir,
R_9: Good afternoon.
I: Oluwasanya is my name. I am carrying out a research on well water in Abeokuta. Some time ago I came to take water sample from this well for testing and saw that it has germs. I came to report back to the owner and to find out what could be the cause of germs in the water.
R_9: I allowed people to have access to the well because of the nature of water problem around here. There is tap water over there but people who want to wash, or bath comes here to fetch water.
I: The last time I came it was during the dry season and despite the low water level, I met several people fetching from the well and now that we saw some disease causing germs in it what do you think can be done because disease is harmful to users.
R_9: It is what you think that we can do. If the grace for such is available; it will make no meaning if we lock it up. It is from you that we can know what to do.
I: When I look at it there are things that we can do like cementing the floor around the well and drainage to allow water to freely flow away from its base. Also the cover is rusted; a cover stronger than this zinc will be better and if we can ring it down to prevent contaminations from nearby toilets and burial sites. These are some of the steps you can take but how possible are they for you sir?
R_9: It is possible. Everything that can cause harm must be taken care off. We can fix the ring and the cover.
I: That is interesting to hear sir. The other thing is about users' operational usage of the well. You don't know where users bring the drawers from, It might be better if you fix a drawer permanently to the well and everybody who wants to fetch water will use it, do you think that this will work?
R_9: It will work. I didn't take money from anybody to construct the well; all that you have said is for our safety after all you are not coming here to fetch water.
I: You think people will follow your rules.
R_9: It will abide, anyone who is not comfortable with it can go else where. There are many wells around. And I am particularly happy about the measure concerning the drawer and I am ready to comply.
I: Another question I want to ask again is that the type of test we are doing since those who are not knowledgeable about it can not do it, if we involve the government to carry out such test on well water so that they will be able to know the quality of water that people are using, will you agree to it as a owner?
R_9: I will give consent to it. I did it for safety and all the rules that go along safety must be followed. I will buy the drawer you talked about and also do the floor after which I will start to look for money to fix the rings.
I: Thank you sir

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R_9: Each time we make a cover, they will break it
I: You don't …………..
R_8: Yes, the tap is not flowing
I: Let me ask again. What do people do when they are sick?
R_9: We use herbs
I: How do you know the herbs to use?
R_9: The well is God given; you can take the water sample and compare it with other 25 and see the difference
I: Is that so?
R_9: Yes
I: Can we say it is only this household alone that uses the well?
R_9: It is for the neighbourhood; that's why we are not locking it again.
I: What is the name of this area?
R_8: Baba Elesin's Compound, Itori-odo
I: Mummy when you are sick what do you do?
R_8: I use medicine
I: How do you know the medicine to use?
R_8: I go to the hospital

I: In the last one year; have you seen a doctor?
R_8: It has been a long time that I saw a doctor last
I: How many months or year is that now?
R_8: One and half years
I: What about your child?
R_8: I took him to hospital recently
I: For what?
R_8: Cough and they prescribed drugs for us.
I: Which drug?
R_8: Antibiotics
I: Do you live here, sir?
R_{10}: Yes
I: What do you do when you are sick?
R_{10}: I buy tablets and also use herbs
I: When last is that sir?
R_{10}: Even recently
I: What are you using?
R_{10}: Herbs
I: What do you use the herbs to treat?
R_{10}: Malaria and body pain
I: Do you know the type of fever?
R_{10}: Yes, I've had typhoid before
I: How do you know it was typhoid?
R_{10}: I did blood test
I: What about your children, in the last one year, have they had Typhoid?
R_{10}: All the children are healthy
I: When they have fever, do you use herbs or buy drugs?
R_{10}: They use herbs too when they are sick or I buy drugs for them at the chemist
I: How do you know the drugs to buy?
R_{10}: We just tell them how we feel at the chemist and they will give us the drugs to use or if it's something that has happened before, we simply take the empty pack of the drugs for a re-fill
I: Are you drinking this well water?
R_{10}: No
I: What are you using it for?
R_{10}: To bath
I: You do not drink the well water?
R_{10}: No.
I: Do you use it for something else?
R_{10}: No, most people do, but we do not.
I: What water do you drink if there is no tap water?
R_{10}: We drink the (tap) water we have at home
I: How old is your child?
R_{10}: He will be 2 years in November
I: What is your name?
R_{10}: Taoreed Adedigba
I: What do you do?
R_{10}: I am a Farmer and a driver
I: What about education?
R_{10}: I did not go to school
I: How old are you
R_{10}: 42 years
I: Are you sure
R_{10}: Yes
I: Daddy, do many sick people come to you for treatment?
R_9: Only those with mental sickness

Sample number: IJM 1
Well location: Lasokun's Compound, Ijemo, Abeokuta
Interview dates: 22/05/07; 19/06/07; 17/07/07

Respondents' profile:

R11
Sex: Female
Age: 25 years
Occupation: Food vendor
Formal Education level: Primary
Well ownership status: Resident user

R12
Sex: Male
Age: 46 years
Occupation: Driver
Formal Education level: Primary
Well ownership status: Resident user

R13
Sex: Male
Age: 15 years
Occupation: Student
Formal Education level: Secondary
Well ownership status: Resident user

R14
Sex: Female
Age: Not obtained
Occupation: Not obtained
Formal education level: Not obtained
Well ownership status: Caretaker

Interviews:

I: Do you drink this well water?
R_{11}: No, we do not. We only use it for bathing
I: What about cooking?
R_{11}: We use for cooking too
I: How many people use this well?
R_{11}: Ha, a lot. It is for the entire household you are seeing around here
I: But there is hardly any water left in the well
R_{11}: It is because there is no rain. The water level is very high during the rainy period. But even as it is, people wait for it to spring up to collect whatever water they can get from it.
I: Who provides the drawer that people use for the well?
R_{11}: Everybody brings their drawers
I: So what water do you drink?
R_{11}: Tap water and sometimes borehole water
I: Is there a borehole around here?
R_{11}: We go and look for it. There is no tap water in the whole of this area from Sapon to Ake area. We really do not know what the government are doing and many of the people in this neighbourhood are old people who need all the assistance they can get from the government.
I: Where is the toilet?
R_{11}: There is no toilet in this area, we do shot put or use the solid waste dumps
I: Why is that?
R_{11}: There is no money and since the head of the household died, getting people to do things is difficult. But maybe you can help us.
I: I will like to carry out some test on the water and take some for more analysis as well
R_{11}: Go ahead, if you find enough to collect
I: I will come back to give you the result and also talk more about the well water
R_{11}: Ok, you will meet us here

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I: The first question is what are the likely causes of germs in your well water?
R_{11}: It is not that we poured the water in there; it is springing from the ground
I: Are you saying you do not know the causes or do not know the corrective steps to take?
R_{11}: Yes
I: But if I tell you what to do are you interested?
R_{11}: Yes
I: There are things that we can do to it, firstly it has no cover mummy said earlier that she does not make water; water springs from the earth, and we believe such water should be clean. If

we find disease-causing germs like the one we discovered in the well water, it means that the usage and the care of the well may not be good enough. The first evidence is that there is no cover. I also asked the question of who provides bucket & rope. You said everybody brings its own bucket to draw. And you can't determine where people pick their buckets from. Thirdly, if the water quality is not good it means there is pollution. For instance, there are burial sites and soak away pit over there. All these contribute to sub-surface flow.

R_{11}: If such things are not around the well will it be better?

I: Now I can't ask us to remove grave site or the toilet nether will I ask you to reposition the well but one amendment is to use the chemical for water treatment that I showed you. I remembered you are said that you are not drinking the water, but your bath with it.

R_{11}: We also use it for cooking, and that means we take it in

I: Is it?

R_{11}: Yes

I: This chemical is N80.00 at Precious and you can use it for a month or two. A cap is okay for 25l of water. It however depends on whether you will be interested to do it or not

R_{11}: What really happened is that this well is public, not owned by a person and that makes it difficult to lock it up.

I: Does that mean that repair works like fixing of the well cover is not going to be done by one person?

R_{11}: No, all the neighbours will have to pay for the cover

I: Is that possible?

R_{11}: Yes, it is possible it can be arranged

I: What about the bucket for drawing out the water?

R_{11}: That can only be possible if there is a cover, those who come to fetch water will meet it locked, and they will ask for key, open it and find the bucket in it. And they will be told to use it. There is another well there. It has cover but it is privately owned by a person.

I: So you can fix the cover and attach a permanent bucket to it?

R_{11}: It can be done like that

I: I will come back in another 4 weeks to see which step you have taken to know if you showed interest and if not why. And if those steps are taken I will take sample for testing to show us the difference

R_{12}: All what you are saying is for our good, but it will be difficult to ask our people to contribute money, but may be there is a help you can render to us on it to put something inside the well.

I: Well water keeps springing. The chemical I showed you will allow individuals to treat the water before use. Is the tap water still running?

R_{12}: Yes, every Thursdays

I: I think if we take proper care of the well water it will be better.

R_{11}: Is well water drinkable without taste

I: Yes that is why I said if you use the chemical leave the water for 30 minutes, taste it and see. When I come back I will ask for your comment.

R_{12}: Please bring one along for me when you are coming back.

I: I can't bring it because I don't have it

R_{12}: I mean I am going to buy it from you

I: I am not selling but you can get it at Precious pharmacy; that is where I bought mine from.

I: What is your name Sir?

R_{12}: Jimi Ogundimu

I: Aunty what is your name?

R_{11}: Is it necessary?

I: Yes I don't want it to be as if I spoke with only the males alone

R_{11}: My name is Toyin

I: How old are you?

R_{11}: 25

I: What do you do for a living?

R_{11}: What you see me doing – (food vendor)

I: What about school

R_{11}: Primary Six

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I: Why didn't you buy the chemical?
R_{11}: I forgot
I: It is up to 5 months now?
R_{11}: Is that?
I: Yes; or is it too expensive for you?
R_{11}: No, I fell sick a little
I: Why don't you send some one to buy it for you?
R_{11}: There is no one I can send
I: What about your husband?
R_{13}: What happened?
I: The water had problem and I brought a chemical that you can use for the treatment the last time I came but she said she has forgotten about it.
I: I am sure that I wrote the name for you the last time I came?
R_{11}: No
I: It is sold for N80.00 at precious pharmacy
I: Do you prefer the one that you will jointly buy
R_{13}: Who are we going to ask to contribute money?
I: It is individual that can buy and use it.
R_{13}: That's what I am saying nobody will want to pay
I: It is not for the well but the water for your personal usage, so the idea of contributing money does not arise
R_{13}: Okay, you can write the name down for me
I: What about the other man I met here the last time. He didn't buy it too?
R_{11}: He didn't buy it.
I: I bought mine for N80.00 please tell others about it
R_{13}: It is one capful for 25l
I: Yes, and if you have a drum, measure it with 25l Jerry can to know the number of capful you will apply. The water is drinkable after use I will try to come next month
I: What is your name?
R_{13}: Segun oke.
I: What class are you?
R_{13}: SS1
I: There is nothing we can put inside the well all we can do is take care of the well.
R_{11}: We will buy what you said and every one will be taking care of his/her own water
R_{13}: How much is it?
I: It is N80.00

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I: When did you do the well cover?
R_{11}: Not long ago
I: Did you all contribute or is it done by one person?
R_{11}: It is mummy that did it
I: You tried. Have you bought the water guard?
R_{11}: No
I: Why? The last time I heard you were sick, what happened now? And it is now 3 months; does it mean you are not going to buy it?
R_{11}: We have not passed the information round.
I: Are you still drinking the water?
R_{14}: Yes, since we use it for cooking
I: So if you use it for cooking it is as good as you drinking it
R_{14}: It is true
I: I suggested earlier that if possible, you should ring the well and fix the cover and use only one bucket/rope. I also show them one household water treatment to use with the water you are going to use
R_{14}: Are we going to use this (water guard) after we fix the ring?
I: No you can use it now but it will be better to protect the well with rings.
R_{14}: How much is this? The children can go and get it
I: N80 naira, yes your children can help you to get it

R_{14}: At where
I: At Precious Pharmacy, Omida
R_{14}: We would hold meeting about the ring. What can we do about the well drying up?
I: Just dig it deeper
R_{14}: We shall do that during the dry season.
I: When last were you sick? I recollect you were ill during my last visit. Did you go to the hospital?
R_{11}: Yes
I: What did you use?
R_{11}: I don't know
I: Did you use herb too?
R_{11}: Yes
I: What about the children?
R_{11}: When they are teething. Our mothers know what to do for the children before the time.
I: I was happy when I saw the cover and I was told that you did it. Why are you not drinking the well water?
R_{14}: We use it for cooking, bathing; some don't drink it because it is tasty in the mouth. It will be better for use if we take better care of it. We shall call a household meeting about the ring
I: Individual household will have to get their water guard
R_{14}: Yes, that is for our personal health.
I: What about the toilet?
R_{14}: There is no place we can build one, this area is all water. We can not dig deep before we reach water
I: Ma, if you fall sick what do you do?
R_{14}: I go to hospital
I: Do you use herbs?
R_{14}: Yes
I: What about the children; how often do they get sick?
R_{14}: Some time, or once in a while
I: What is the nature of their sickness?
R_{14}: Malaria or temperature (fever)
I: Do they have diarrheal?
R_{14}: No, not at all.
I: Thank you

Sample number: IJM 2; Group 1
Well location: Behind IJM 1, Ijemo-Ake road, Abeokuta
Interview dates: 22/05/07; 19/06/07; 17/07/07

Respondents' profile:

R15
Sex: Male
Age: 34 years
Occupation: Driver
Formal Education level: Secondary
Well ownership status: Source owner's son

R16
Sex: Female
Age: 22 years
Occupation: Trader
Formal Education level: Secondary
Well ownership status: Resident user

R17
Sex: Male
Age: 54 years
Occupation: Driver
Formal Education level: Secondary
Well ownership status: Resident user

R18
Sex: Male
Age: 27 years
Occupation: Police officer
Formal education level: Higher
Well ownership status: Resident user

Interviews:

I: I need to know what you think are the causes of water contamination
R_{15}: We use it in the house for washing cloth and bathing and it has no adverse effect on us
I: You mean you don't drink the well water?
R_{15}: No we don't, we drink tap water
I: And you always have the tap water?
R_{15}: No, we go out to look for tap water with jerry cans when our tap is not flowing
I: As the well is within your reach what do you think can be done, or don't you allow others to access it?
R_{15}: What I think is that if you have anything to use for the water, you can give us or if it is that we are going to buy we will
I: If there is anything that you can do to improve the well are you willing to do it?
R_{15}: Yes since it is not going to harm us, it is for our benefit.
I: There are things to do, looking around the well area; probably that is toilet over there and such should be at least 10 m away from the well, the burial site and the dirty drainage can affect the well.
R_{15}: The land owner owns the graves and this gutter comes from the other compound there is no other way to channel it through.
I: What about constructing a drainage for the well and channel it to the bigger drainage here?
R_{15}: You can see that after the last time you came we have raised some block here for the gutter (drains)
I: If we leave this issue of contamination from under the ground because we can not remove this burial site or decide to find a new place for the toilet because it seems that everybody has used up their landed property. Can we try household water treatment? I have a sample here.
R_{15}: Water guard
I: The Instruction is on it.
R_{15}: How much?
I: It is eighty naira. One cap full is okay for 25l you can use this bottle for a month.
R_{15}: Where can we get it?
I: At Precious Pharmacy outlets. The other thing is what we introduce into the water. I asked last time whether people from outside are using this well and they said yes. I also asked if they bring individual bucket, the response was yes. I know that this may be a source of pollution if we find germs in the water because you can not say where they pick such bucket from. You have made a cover even though it is still leaking, so my advice is repair the cover and fix a permanent bucket to the well for people to draw water out from the well. These are things you can do. It is up to now whether you will be able to or not
R_{15}: It is easier to do; it is for our safety and benefits.

I: I am happy that you said you can do it. I will leave 4 weeks and come back here again, then I will take sample of water that you have already treated, test it and compare the result with the former test; if there is difference you will be able to see it yourself.
R_{15}: Can I have this chemical?
I: No I am still going to other places and will need to show it to them. What is your name?
R_{15}: Mr. Seye
I: How old are you?
R_{15}: 34 years
I: What is your occupation?
R_{15}: Driver
I: Your education level
R_{15}: Secondary school
I: How can I see you when I come back?
R_{15}: If you do not meet me you will see the others
I: But you are the one I spoke with
R_{15}: I will tell others what we discussed
I: Tell them also to be expecting me again.

I: Are you not drinking the water too?
R_{16}: No, but we apply the chemical you showed us into stored tap water
I: Do you know this chemical before?
R_{16}: Yes, we have it at home
I: How do you learn about it?
R_{16}: It is my husband that bought it
I: Can I have some of the water for test?

I did the nitrates check and showed the respondents the results
You see that the result for your water (water guard treated tap water) is not up to 10; it is five.

R_{16}: The tap water sometimes is also dirty that is why we bought and use water guard
I: If we take care of the well and use the water guard it will also be safe for use. Aunty what is your name?
R_{16}: Mosurat Obadeyi
I: How old are you?
R_{16}: 22 years
I: What is your occupation?
R_{16}: Trading
I: What about education?
R_{16}: S.S.S. 3

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I: I did some water testing here last time the minimum value given to us by world health organization is ten but the nitrate value for their water read 5 and that indicates that there many be no virus in the water we tested and when the result came out it was so
R_{17}: That was the time people are saying that you are advertising the product.
I: I am not selling the product.
R_{17}: This is a chemical for the treatment of water; one cap is for 25l and is ready for use after 30minutes.
I: The reason why I came again is that the water is bad and has germs but if we can do some amendments we can make it safe for use by using this chemical (Water guard).
R_{17}: What do we need to do?
I: I spoke with the landlord's son about this floor; there should have been a gutter, also the closeness of this toilet to the well.
R_{17}: As tenants there is nothing we can do. We can't do it on our own
I: What about if you talk to the landlord?
R_{18}: We have about 4 landlords in this place. What I will say is that let every man fetch his water and treat it. If you come back in the next 3 years you'll meet the well the same way it is now.
R_{17}: I boil my own water before use but if there is no light (electricity) nothing can be done.

I: Boiling has own limits but this chemical will kill the entire virus. What I will do is that I will come again in another four weeks time. When you start using this treatment I will like to take sample of the water for examination and bring you back the result again so that you can see. There is one I did and showed to your wife last time I came, what is you child's name?
R_{18}: Hadijat
I: I will come for the sample and you will see.
R_{18}: It is a good advice, it is for our benefits. It is useful, if I go out now I can help you to buy it and one for myself.
I: What is your name, sir?
R_{17}: Kamilu's father
I: What do you do?
R_{17}: Driver
I: What is your educational qualification?
R_{17}: Primary School
I: How old are you?
R_{17}: Forty-five years
I: What is your name?
R_{18}: Mr. Rasheed
I: What is your educational level?
R_{18}: Technical School
I: How old are you?
R_{18}: Twenty Seven (27years)
I: I will be back this time next month

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R_{18}: The water guard I bought it and use it alone
I: Are you sure?
R_{18}: Yes, I bought it from Adatan
I: What difference did you notice?
R_{18}: All is well
I: When you applied the water guard did you notice any changes?
R_{18}: Yes.
I: Do you go to Hospital recently?
R_{18}: No
I: What about your children?
R_{18}: They don't fall sick

Sample number: IJM 3; Group 1
Well location: Agbaje's Compound, Ijemo, Abeokuta
Interview dates: 22/05/07; 19/06/07; 17/07/07

Respondents' profile:

R19
Sex: Female
Age: 40 years
Occupation: Trader
Formal Education level: Primary
Well ownership status: Resident user

R20
Sex: Female
Age: 30 years
Occupation: Trader
Formal Education level: Secondary
Well ownership status: Resident user

R21
Sex: Male
Age: Not obtained
Occupation: Student
Formal Education level: Primary
Well ownership status: Resident user

Interviews:

I: Your water has germs and I want to ask what do you think is responsible?

R_{19}: I don't know. When they want to dig the well, I know that the area is a very dry and hard soil that we do not even expect water. When water problem (scarcity) became unbearable someone suggested that we should dig well here. That is how the well was dug and ring was fixed, but one day one boy said he saw a germ inside the water and that prompted me to call one family member who is a veterinary doctor to test and examine the water for us. That is why I can't deny what you have said about finding germs in the water sample. That is also why we are not eager to use it for cooking. Again with people staying there to wash cloths and we can't control ourselves.

I: What do you think you can do?

R_{19}: I don't know, even if you tell me anything I will still need to tell my father-in-law because I am only a wife here

I: If you tell them do you think they will be eager to address the problem?

R_{19}: Yes, they will do it. My husband is literate and he will comply with whatsoever. The well has a cover before but the demise of my mother-in-law caused all the misuse.

I: You said you do not drink the water how careful are you with preventing your children from drinking it?

R_{19}: Yes, it is true children when they are thirsty will drink any available water.

I: I will tell you my observations and what I think can be done; It will then depend on whether you will do it or not

R_{19}: Tell me about it first.

I: Firstly, what we do in the well environment causes pollution. See, washing within well area……….

R_{19}: Between today and tomorrow I will put a cover and lock it up………

R_{19}: She came one day and took sample of the water saying that she wants to know weather it is dirty or not. Come Ma, my co-neighbor, we both use the water together for cooking and so on.

R_{19} I will move the hen cage away from that place too, they defecate there, and they can also be the cause of the problem.

R_{20} What happened?

I: Your water was tested and found to contain E. coli, a germ that can cause cholera or diarrheal.

R_{20}: God forbid such in our area.

I: That is why we came again and to ask you of how you have been using the well that resulted in such a state.

R_{19}: I don't see anything beyond how we are using it because firstly we are covering it, secondly one day when a goat enters into it, we removed all the water and now that you said you discover things, it surprise us.
I: Do you use only one bucket or individuals have their own?
R_{19}: We can say that we are using one doro (drawer) even if other people are bringing their own, I have mine.
I: But do you know where others pick their doro from?
R_{20} We are all using it and even some are coming at night they bring their doro too since it has no cover.
R_{19} What I am saying is that since they will be using the water for drinking and cooking, they cannot use dirty bucket to draw water from the well.
I: You can only speak for yourself; can you be sure about others?
R_{19}: When we are not at home, we do not leave this (doro) for anyone to use.
I: What am saying is that the well is not covered, so when you are not at home how do you guaranty the usage of clean drawers?
R_{20} What you are trying to say is that care must be taken about the buckets we use
I: Don't you think you should?
R_{19} Why I ask you to be called is that this place nothing should be washed here (the well area). In my own space I know that my hens sleep over there and I have decided that they will be moved away. If I do that, then this container also should be removed. And also we should clear this (the well area) place.
I: It seems that the well is ringed to the bottom.
R_{19}: Yes we ringed it.
I: You can also repair the cover so that it can be locked, then the doro that you will be using will be tied to the cover and dropped into the well.
R_{19}: I understand that, to prevent the doro from not touching the ground.
I: I have a water chemical to introduce to you. It can take care of germs. When you draw the water you can use the chemical to treat it. One capful is for 25liters.
R_{19} I need to buy it because of the children it is the water they see that they drink.
R_{20} We must all be vigilant even the children most time they bath here, and urinate beside the well.
I: Everything that can cause harm must be taken care of.
R_{19}: All water goes down into the well that is why I am talking now because when people start this habit again I will tell them am acting on what we are told.
R_{20} Are you going with the Water Guard?
I: Yes, but Precious Pharmacy is selling it
R_{19} Where is that?
I: One is at Omida, Abiola way and Adatan
R_{19}: That Adatan is very near. Are you always going that way, she can write it for us so that we can buy it for the advantage of us that's using the water.
R_{20} Where ever dirty water is it is very dangerous to health and this well is useful to us all.
R_{19} We must all sit and talk about the care of this well because it is when we are healthy that we can move round.
R_{20} It is for the benefit of all we would make an end of it, all this rubbish must be parked away.
R_{19} Bro. Muka, these are the people who came sometime ago to examine our well. They are here today with the result that the water is not good. She had advised us that a good cover should be made. One bucket must always be in the well for drawing. A pavement with drainage to be made around the well and also when we fetch the water we must treat it with this chemical and we have said that we are going to do all to prevent epidemics. They have described where to get the chemical.
I: I will take sample of the water again to see the effect of rains on it.
R_{19} Erosion is not getting into the well
I: I will come back in two weeks to see which of what you said have been done and if you have started treating the water I will take sample of that too. To see if there is any difference and I will come to give you the result.
I: What is your name?
R_{19}: Bosede Abiodun
I: Your occupation

R_{19}: Trading
I: How old are you?
R_{19}: 40years
I: Your education?
R_{19}: Primary Six
I: Aunty, what about you?
R_{20} Adesile
I: Your work
R_{20} Trading
I: Your age
R_{20} 30years
I: Education
R_{20} S.S. 3
R_{19} I can even tell one of my in-law who treats guinea worm patients to come and treat the well for us
I: I am sure he will be using chlorine, but I think it is better for every one to treat his own water.

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I: Has the issue caused problem again?
R_{19}: May God build a house for every one of us. 'This thing is mine, is different from it is ours'! Among my promises to you I have cut down that tree.
I: Oh good! Did you buy the chemical?
R_{19}: I've tried about 3 times now but sent my neighbour. I have not been able to go to the Abiola way myself; I have the paper you gave me in my bag.
I: If Abiola way is far from you, Adatan is nearer to you
R_{19}: Did you mention Adatan too?
I: There are 3 precious outlets one at Omida, Adatan and Abiola way.
R_{19}: I can't go to Omida, but each time I want to bath I will use antiseptic soap. After sending my neighbour three times and she couldn't get it even though she too is using the water. The effort I'm making to buy the water guard is because I use the well water for bathing; I don't drink the water.
I: I was some where this morning they also said they don't drink well water but only use it to bath. It happens that the mother put her child inside a basin of well water and left to pick the bathing soap. By the time she came back the baby was already playing with the water and drinking it. And I told her it is self deceit to say she does not drink the well water.
R_{19}: I want to buy it but having to go to Abiola way has been my major constraint.
I: I think Adatan is closer to you and you can ask from other pharmacies as well
R_{19}: Can we get it at other pharmacies?
I: Yes, I think so
R_{19}: We thought it's available only at precious.
I: No it is because I bought my own there and I am sure that people can get it there
R_{19}: We may get it at other chemist then, I will try the one at Sapon
I: It is all over in Lagos
R_{19}: I have been telling every one that the well has problem. I tried to put the bucket on the cover yet they will remove it and put it on the ground after use. And now I don't place the bucket in the open.
I: What I will do now is that I will come again but then I will come with one of my supervisors.
R_{19}: Ok, no problem

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I: What happened to you then?
R_{21}: Headache
I: When you got to the hospital what did they say?
R_{21}: They spoke with my Mummy
I: Which drug were you given?
R_{21}: I don't know

I: What about others in the family?
R_{21}: No, except yesterday
I: What happened to you yesterday?
R_{21}: Headache
I: What about your younger ones?
R_{21}: They use to have stomach pain
I: What is the cause of the stomach pain?
R_{21}: I don't know
I: Is it the food or something they are using?
R_{21}: They have big navel
I: And you think big navel causes pain for them?
R_{21}: Yes, especially the younger girl
I: oh, ok. Thank you

Sample number: IJM 5; Group 1
Well location: Ijemo-Ijako Road, Abeokuta
Interview dates: 22/05/07; 19/06/07; 17/07/07

Respondents' profile:

R22
Sex: Female
Age: 28 years
Occupation: Hairdresser
Formal Education level: Secondary
Well ownership status: Resident user

R23
Sex: Male
Age: 70 years
Occupation: Trader
Formal Education level: Secondary
Well ownership status: Source owner

R24
Sex: Female
Age: Not obtained
Occupation: Not obtained
Formal Education level: Not obtained
Well ownership status: Resident user

Interviews:

I: We took water sample of this well in our first visit. The result shows that there are some disease-causing germs in the water.
R_{22}: What can we do to it now?
I: The question is what you think is the cause?
R_{22}: We are new here; we just came here, just about a year ago.
I: What did you notice within that one year? Is this a pit latrine? (Referring to nearby lock up rooms)
R_{22}: No
I: Are you using water system type of toilet?
R_{22}: Before, but it is not good again. They have stopped using the Water system because there is no tap water
I: Where is the soak away pit located…..Good morning sir
R_{23}: Good morning
I: I've brought the result sir
R_{23}: What is the result?
I: It contains E. coli that causes cholera and diarrheal. Could you please tell us what you think may be responsible for this?
R_{23}: Well it may contain it but there is no one here who has had cholera since I have been using the well?
I: Do you drink the well water?
R_{23}: We are not drinking it at all only for bathing and cooking
I: What do you think can be done?
R_{23}: What can we do?
I: You own and use the well you should be able to say?
R_{23}: I don't know what we can do about it
I: Do people come to draw water from outside
R_{23}: Yes
I: Can you say whether they drink it?
R_{23}: No one is drinking well water here but if you think there is anything to do
I: Are you sure that people do not drink well water around here?
R_{23}: That's how it is
I: There are things you can do but we don't know whether you will be willing to do it. Every thing depends on you now. First the absence of cover may be a major problem
R_{23}: It has cover before and we are planning to replace it
I: What about fixing a dedicated bucket? The pit latrines also, how deep are they?
R_{23}: It is about 12^{ft} deep

I: So it is deeper than the well
R_{23}: Very well. It is rock that prevented us from digging the well deeper here but it is not so with the latrine. *(The well has natural rock lining)*
I: This chemical is useful for household water treatment. You can use it to treat the water before use. I have the sample here it is called water guard. Precious sells it; it is just N80.00 and a capful is okay for 25l. When you apply it, leave it for 30minutes it is ready for use.
R_{23}: We would; all you are saying is for our benefit.
I: What I will do now is I will take the water sample now and come back in June. If you have started using the chemical I will take a sample of the treated water and bring you the result.
R_{23}: There is nothing hard out of all you have said this is just N80.00 and after 30minutes the water is ready for use. It is easy.
I: Please what is your name?
R_{23}: Evangelist S. A. Kehinde
I: How old are you?
R_{23}: 70 years
I: What do you do?
R_{23}: Trading
I: What is your educational level?
R_{23}: Secondary School
I: What is your name ma?
R_{22}: Mrs. Tope Mudasiru
I: How old are you?
R_{22}: 28yrs
I: What are you doing?
R_{22}: Hairdresser
I: What about your educational level
R_{22}: Secondary School
I: Thank you.

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R_{22}: I have not been to town in four weeks? It is not up to four weeks
I: It is four weeks; I told you that I will be back in four weeks
R_{22}: Let me call others in the house.
I: Okay
I: Have you bought the water guard?
R_{22}: What?
I: So you don't even know what we are talking about?
R_{22}: I don't know
I: When is the last time your child was sick?
R_{22}: About a month ago
I: What was the sickness?
R_{22}: He was coughing.
I: Has he ever had dysentery?
R_{22}: No
I: How did you treat him when he had cough?
R_{22}: A drug was prescribed for us at the hospital
I: If you are sick, what do you do; do you go to the doctor or herb seller?
R_{22}: No. I know herbs, we only have minor sickness
I: What do you mean by minor; you don't fall sick or what?
R_{22}:
I: Do you use herbs?
R_{22}: Yes for bathing

I: Aunty what is wrong with your child?
R_{24}: Nothing
I: They said he is teething
R_{24}: Yes
I: What did you use for him?

R_{24}: We took him to the hospital in Lantoro (The biggest private hospital in Abeokuta)
I: Which drugs were they given?
R_{24}: I don't know it
I: Is it Bonababe?
R_{24}: I don't know.

Sample number: ABW 2; Group 1
Well location: Iga Soyombo Street, Ijeun-Titun, Abeokuta
Interview dates: 22/05/07; 19/06/07; 17/07/07

Respondents' profile:

R25
Sex: Male
Age: 75 years
Occupation: Retired civil servant
Formal Education level: None
Well ownership status: Source owner

R26
Sex: Female
Age: 35 years
Occupation: Dress maker
Formal Education level: Secondary
Well ownership status: Resident user

R27
Details not obtained

R28
Details not obtained

R29
Sex: Male
Age: 47 years
Occupation: Security Officer
Formal Education level: Secondary
Well ownership status: Resident user

R30
Sex: Male
Age: 30 years
Occupation: School Teacher
Formal education level: Higher
Well ownership status: Owner's son

Interviews:

I: What do you think can cause such things since you are the user?
R_{26}: We use it, drink and cook with it and nothing happened to us
I: Since when have you been living here?
R_{26}: 1994
I: And no one has cholera?
R_{26}: No
I: How do you take care of the well?
R_{26}: We only cover it
I: Is the landlord living here?
R_{26}: Yes, but he is not at home now
I: So you don't know what you can do?
R_{26}: I don't know……

I: If I tell you what to do, will you do it?
R_{25}: Yes
I: Do you think other users will comply?
R_{25}: Yes
I: Assuming we call government to oversee the well for us, will you accept it?
R_{25}: Yes
I: There are steps that we can follow. Since you are the Landlord is it possible to build an apron round the well with drainage for the flow of water. Will that be difficult to do sir?
R_{25}: It is not
I: What about fixing a good cover and maybe fix ring that will prevent contamination from sub-surface.
R_{25}: I will do it
I: Is it possible to have a bucket dedicated to the well?
R_{26}: It is not possible because when people borrow it some may not return it
I: If I suggest that such bucket should be attached to the cover, dropped inside the well and when people come they use it and return it back, will that be possible?
R_{25}: It is possible
I: Also have you heard about a chemical that kill water germs
R_{25}: Yes
I: How did you learn about it?

R_{25}: I can't remember
I: I learnt that one is in the market now at Precious Pharmacy it is called water guard, will you be interested in using it?
R_{25}: Yes
I: The reason why I am asking is that I will want to come back next month to see if you have taken any of the steps and I will want to take some of the water you treated and test it to see if you take the steps and if there is one step that you take and didn't work, I will want to know why.
R_{26}: If we buy the powder
I: No it is not a powder it is a liquid. And the water you have already treated is not the one that you will put unclean hand into
R_{26}: Okay
I: How old are you?
R_{26}: 35 years
I: What is your name?
R_{26}: Mrs. Olatoye
I: What is your occupation?
R_{26}: Fashion designer
I: Your educational level
R_{26}: Secondary school
I: what is your name sir?
R_{25}: Jimoh Ibikunle
I: How old are you
R_{25}: 75yrs
I: What is your work?
R_{25}: Retiree
I: Your educational level?
R_{25}: None

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I: Have you done it?
R_{25}: No
I: The rain didn't change anything. Did you buy that chemical?
R_{27}: I was not at home
I: Didn't they tell you what I ask you to buy?
R_{25}: Did you ask us to buy anything?
I: I told you that you will get it at Precious Pharmacy
R_{25}: You only told us to attach a bucket to the cover
I: After all our talk I asked you to buy this water guard and I told you that I will come to take sample of the one that you've treated.
R_{25}: No you told us to draw the water and that when you visit again you will take sample from the one we have at home.
I: Anyway, I have it with me today. It kills germs in the water. The instruction is there; for 25l it's just a capful
R_{25}: What about if we want to pour it inside the well?
I: You can't pour it into a well
R_{25}: How much are they selling it?
I: It is N80.00
R_{26}: Where can we get it?
I: Precious Pharmacy, Omida
R_{26}: Can we use it for tap water
I: Yes.
R_{26}: Will the water be drinkable
I: Yes, you can use it for drinking, cooking, etc.
R_{26}: okay
I: About all I told you to do concerning the well. I can see that you are yet to attach the bucket
R_{26}: We have not done that because the wood after a long time in the water becomes weak and the bucket fell inside the well.

I: Can't you use the Hausa's bucket?
R_{26}: This (paint bucket) is better than the Hausa's
I: Do you have some well water at home?
R_{26}: Yes
I: Please, give me some. I don't know if I showed you this chemical the last time I came. Please try and buy it and use it.
I: I will come back next month to take sample of the water you would have treated.
R_{26}: After treatment, can we drink the water?
I: Yes, apply the chemical and leave for 30 minutes.
R_{26}: Are you going to visit the other well around here.
I: No, I can't visit the entire well; you have some friends there tell them everything I told you.
R_{26}: Where can we get the chemical?
I: I bought this at Precious Pharmacy at Omida, it is N80.00

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I: What about the other aunty; is she at home?
R_{25}: No she has gone out
I: I showed you this thing the last time I came and you promised to show it to her too.
R_{25}: She has not come
I: What about you?
R_{27}: We are tenants here
I: Are you using the water?
R_{27}: Are you asking us to buy this?
I: When I came last time we discovered germs in your water and I discussed with daddy.
R_{27}: She is not at home now
I: Do you have some of the well water inside the house
R_{27}: No
I: I told daddy about the hygienic steps to take and daddy promised to tell his wife and children. The steps to take if he can fix the ring put a cover make a concrete floor round the wall and make use of one bucket to draw out water from the well and stop people from bringing their drawing material.
R_{27}: All that you have said now those who can do it are not around, the man you talked to cannot do it (because he is old and depend on his wife and children now) and every one of us here now is parking out soon, the landlord's son also is not here.
I: Were you given a quit order or you are trying to find a better house?
R_{27}: They said they want to use the house. You can see that those that you met before are not here now, they had parked out. If we are still going to be here we can cooperate and do it but it would have been better if the landlord's son is here.
I: Won't you see him before you go?
R_{27}: May be. The only thing that we can do is get our own individual water guard for our personal use. We don't drink it because of the taste; it doesn't taste like other water
I: Water guard is chlorine, and that's why I am saying that if you could improve the well plus the household treatment there is nothing that stops you from drinking it.
R_{27}: Will this change the taste? If the taste changes we would drink it.
I: Will you try it?
R_{27}: We will try it, but all this things we are talking about is money
I: The chemical is N80.00
R_{27}: What you are saying is good and everyone like better things
I: Okay I hear you
R_{27}: I will try the water guard and pour everything inside the well
I: No, not inside
R_{27}: Okay after fetching it
I: Yes the instruction is on it
R_{27}: Is there any point in buying the water guard since cholera can not be contacted except by drinking the water and we are not drinking the water but use it only for washing?
I: You said that you use the well water for dish washing; do you have a napping to dry water from your plate after washing with well water?

R_{27}: Okay I get what you are saying, I will buy the water guard and use it and tell others about it also.
I: Every household can get for themselves, but I will still like to come back to see how far you respond to these
R_{27}: I promise you that by the time you will come back; you will have a positive response from us.
I: Thank you

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I: Daddy you have started painting the house
R_{25}: Yes
I: When will you commence work on the well?
R_{25}: By month ending
I: Is that your plan?
R_{25}: Yes
I: Do you still remember what work you need to do on the well?
R_{25}: Yes, that we should make concrete floor round it and a good cover
I: What about the lining?
R_{25}: I've explained all that to them
I: Did they agree to it?
R_{25}: Yes
I: Daddy you said you have planned to renovate this well, when will that be?
R_{25}: Formerly it should be month end, but when our people come it may be sooner
I: Like when will they come?
R_{25}: I can't say
I: What about supervising people bringing different doro (drawers)?
R_{25}: We shall take care of that
I: Do you remember the water treatment chemical I brought last time?
R_{25}: Yes I do
I: Have you used it?
R_{25}: No
I: Good morning Aunty
R_{28}: Good Morning Ma
I: Have we met before?
R_{28}: No
I: This is the forth time we are coming here; we've spoken to people about this well. The last time I came some one in the house said they have been served quit notice.
R_{28}: Yes
I: What about you, were you served a quit notice?
R_{28}: No
I: I took the water sample the last time I came and said I will come back if it has problem and that is why I came back. Are you using the well water?
R_{28}: Yes, for washing cloth
I: What about bathing?
R_{28}: Yes, when there is no tap water
I: Where is the nearest tap water here?
R_{28}: Down there
I: What else do you use the well water for?
R_{28}: It is just for washing
I: What about cooking food?
R_{28}: No
I: Is it only this household that uses the well water?
R_{28}: People come from outside
I: Like how many are they?
R_{28}: They are many if there is no tap water
I: But if counted, how many would they be?
R_{28}: They are more than twelve (12).

I: Does that exclude people in the house?
R_{28}: No
I: But how many are those coming from outside?
R_{28}: About four (4)
I: Only four?
R_{28}: That's how much I can count
I: You don't cover the well, we met it opened.
R_{28}: It was the person that used it last.
I: Supposing we ask you to renovate it, can you (tenants) and the Landlord cooperate and raise money to do it.
R_{28}: Yes
I: Now about the doro (bucket/rope) does individual bring theirs or they use your own?
R_{28}: Individuals have their own
I: What do you do when you are sick?
R_{28}: I really do not get sick, so I do not know how to answer that.
I: You've never fallen sick before?
R_{28}: No; may be slight headache, which comes and goes
I: In the last one month?
R_{28}: No
I: What about six month or a year ago?
R_{28}: I have not been seriously sick since I grew up
I: What about that little sickness, what did you do?
R_{28}: I can't remember
I: What about your children?
R_{28}: No, not recently. They also don't fall sick
I: What about you?
R_{27}: I don't get sick
I: You expect us to believe that you have never been ill?
R_{27}: I've been sick but not recently
I: When last was it?
R_{27}: Last year
I: What was the illness?
R_{27}: It was cold (flu)
I: What medication did you take?
R_{27}: Paracetamol

I: Do you live upstairs or downstairs?
R_{29}: Downstairs
I: We learnt that, those living downstairs have been served quit notice
R_{29}: Who told you that?
I: The occupants here. We are here because of the well and this is our forth time. We came before the rain started and took some water sample for examination and we said that if we discover anything we shall come back, we came back and we are told that there is nothing they can do about that, they are tenants and they have been served notices to quit the residence. But each time we came we always met Daddy who agreed that after the on-going house renovation, he will attend to the well.
R_{29}: It will be better to see the landlord's son
I: Yes, someone suggested that earlier, but we are told that they live far away.
R_{29}: I will send someone to get him
I: Is the place far?
R_{29}: It's not so far away
I: Ok. Can the tenants agree together on maintaining a clean well area or take care of the well?
R_{29}: Yes, but we don't use the water for cooking or drinking just for bathing. We use tap water for drinking and cooking
I: So, you prefer to go and get water from outside rather than using the well water?
R_{29}: We do not drink the well water or use it
I: Why don't you?
R_{29}: Since we have tap water we do not disturb ourselves

I: Does the tap flow often?
R_{29}: Yes, it's working presently and it works often, about three times in a week. This one (well) is just for bathing.
I: So you bath with it?
R_{29}: Yes
I: Do the kids use it too?
R_{29}: Yes, is there any kind of water that is different for kids and adults?
I: What I mean is that kids may not know the difference, water is water to them. So while bathing they may play with the water and even swallow it
R_{29}: No, the children knows
I: How old are the children you are talking about?
R_{29}: They know that this is not tap water and we are not drinking it.
I: You don't expect like a year old baby to know the difference?
R_{29}: Their mother takes care of them
I: There was a place, they told us they are not drinking the water but they put a child in a basin to bath, but they forgot the soap inside and went for it. Before the mother returns the child has been drinking the water.
R_{29}: Where was that?
I: Abeokuta here
R_{29}: Our women are very careful here
I: Do you use it for dish washing
R_{29}: Yes,
I: So, you are saying that you will not take care of the well because you are not drinking it.
R_{29}: Is anything wrong with the well now?
I: Yes we saw disease causing germs in it.
R_{29}: Ha, ok. Well I am not a magician
I: That's why we came back to find out the cause(s) of the problem. Some of what we have seen are that the well has no ring or cover, people come with their different doro and if these are the causes, what can we do and now that we know what to do the next question is who will do it?
R_{29}: You can do it for us.
I.: No, I don't live here and I am not the one using the well water.
R_{29}: I understand you.
I: Sir, when last did you visit a hospital?
R_{29}: Only when I am sick
I: When last were you sick?
R_{29}: It has been a long time
I: Your last visit to the hospital what were you treated for?
R_{29}: I was sick because of the work I did on my farm
I: The last time you went what were you treated for?
R_{29}: It was the health centre at my place of work; they just prescribed drugs and asked me to buy them
I: Ok

I: Good morning sir
R_{30}: Good morning Ma
I: You are the Landlord's son
R_{30}: Yes
I: I've left some messages for you about the maintenance of this well
R_{30}: You are recording my voice hope you will not play it on air OGBC
I: No, we are not from OGBC. What's your name sir?
R_{30}: Taiwo Ibikunle Mr.
I: What is your occupation?
R_{30}: Teaching
I: How old are you?
R_{30}: 30 yrs
I: What's your education qualification?
R_{30}: H. N. D.
I: Is it in order if we call you landlord?

R_{30}: No, my mum is the landlord
I: The first time we came, we took some water sample
R_{30}: Yes, I was told
I: We promised to come back if there is any concern, eventually there was and we came back but those that we met said they have been served a notice to quit.
R_{30}: It is true
I: We always met daddy who promised to deliver the message to his wife and the owners. Also some of those that we met earlier said they are non-resident. Since you live here I want to ask you, what could be responsible for the concern (E. coli in water)?
R_{30}: Well I don't know, people that come to draw water come with clean buckets
I: Do you think so?
R_{30}: Yes
I: Do you know where they pick their bucket from?
R_{30}: I don't know the source. They have told me about fixing a cover to the well with a drawer bucket, we are looking forward to do all that is recommended, as soon as we finish the house renovation, we would start the work. Ordinarily people use the water to wash cloth and don't know whether the bacteria can contaminate the cloth or there are any contagious diseases when they use it to wash cloth.
I: Are you saying that you may not attend to the well if the disease they cause is not contagious?
R_{30}: We would still do it but a quick attention will be given if it is contagious.
I: What about water diseases like cholera, diarrheal etc what priorities do you want to give to that?
R_{30}: We will look quickly into that now that we all know that water is life
I: If I will have to come back how soon will you start the work?
R_{30}: You know the situation in our country, nevertheless we will do it. All you are doing is to help us.
I: To be exact what are the things that you intend to do now?
R_{30}: Fix a cover, and make sure it is always closed, no multiple use of doro. You said we should also put ring and if we put ring cover will that kill the virus.
I: No, but it can prevent the virus. I brought this chemical, it is called water guard.
R_{30}: Yes, they mentioned it to me
I: I just want to show you
R_{30}: This one will kill water germs?
I: Yes
R_{30}: How much?
I: N80 and it is available in all Precious Pharmacy Outlet
R_{30}: I will try and get it.
I: The instruction on how to apply it is on it. You apply a capful to 25l of water; leave it for 30 minutes before use.
I: Another thing when last did you go to hospital?
R_{30}: Long time ago, except when I am sick or I take the children there.

Sample number: OKA 5; Group 1
Well location: Old Blue house, opp. Alayo Clinic, Oke-Aregba, Abeokuta
Interview dates: 21/05/07; 18/06/07; 16/07/07

Respondents' profile:

R31
Sex: Female
Age: 25 years
Occupation: Photographer
Formal Education level: Secondary
Well ownership status: Resident user

R32
Sex: Male
Age: 35 years
Occupation: Police officer
Formal Education level: Secondary
Well ownership status: Resident user

R33
Sex: Male
Age: 37 years
Occupation: Police officer
Formal Education level: Secondary
Well ownership status: Resident user

R34
Sex: Male
Age: 37 years
Occupation: Soldier
Formal education level: Secondary
Well ownership status: Resident user

Interviews:

R_{31}: Do we have something to discuss
I: Yes, I told you that if you see me again it means your water has germs. What do you think is the cause of germs in your well water?
R_{31}: Maybe because we don't cover it or the buckets that we are putting into it.
I: What do you think you can do to prevent the germs?
R_{31}: I think that you will bring us a chemical that we can pour into the well.
I: If you pour in chemical and still open it and use different buckets in it do you think the chemical will work?
R_{31}: Then we shall have to call a meeting that only one bucket for drawing the water must be used.
I: Do you think that rule will work?
R_{31}: I can't say until we have such meeting and see the response of others. It is just my suggestion.
I: The Landlord is not living here, is it?
R_{31}: Yes (she meant no)
I: If we are using the water in any form either washing, cooking or drinking. It will definitely have effect on us. And from all that you have said don't you think you should reach an agreement on it?
R_{31}: You know that we are not equal. If you come around over the weekend you many have the opportunity to talk to every one.
I: Around what time do you suggest by weekend?
R_{31}: May be 5.00pm on Sunday
I: Okay I will do that and because of the rain I will come around again
I: What is your name?
R_{31}: Is it necessary?
I: Yes I take the names of every one I speak with to show that it cut across gender and ages
R_{31}: Will it not create problem for me?
I: Not at all I have several other names here
R_{31}: Mrs. Ogunbayo
I: How old are you?
R_{31}: 25 years.
I: What do you do for a living?
R_{31}: Photographer
I: What about your educational level?
R_{31}: Secondary school

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I: I told them I will come back if the water contains disease causing germs. I came back and I spoke with her but I was told to come on Sunday evening but I didn't come that Sunday because I was sick. Are you living here too? I ask them about what can cause the problem.

R_{32}: We don't cover it and people are using different bucket to draw water from the well.

I: Can we do anything?

R_{32}: What can we do?

R_{33}: Are we to repair it? The landlord only comes to collect his rent and go away.

I: What about if you inform the landlord that we came here and we said that there is virus in the water.

R_{33}: I am a police man I don't want to involve myself.

I: Let me introduce myself. I am from UNAAB Abeokuta. We are carrying out a research on water especially in Abeokuta. In our first visit, we took sample of the well water for testing. We found the water quality questionable, so we are here to see the users to find out what is responsible for the problems and what they want to do about it.

R_{33}: There is always this type of problem in a house where the Landlord is not staying with them. It is the caretaker that comes here to collect money, the landlord and his son may not come for months.

I: Now that we know there is problem, if you tell the landlord or the caretaker don't you think they will respond to you?

R_{33}: We are many here; if you have met me the first time I would have called a meeting to discuss the issue.

I: The lady I met earlier mentioned problems of well cover and buckets. Do you think you need the involvement of the caretaker for the cover or restriction of multiple use of drawing bucket? For instance take a look at the bucket on the ground and people will pick it up and put it inside the well. The well also is not lined; you can fix rings in it. Do you think it will work if you talk to yourselves about the care of the well?

R_{33}: Yes, it will work

I: I want to introduce this water guard to you; it is used for water treatment

R_{33}: How much is it?

I: It is Eighty Naira. It is available at Precious Pharmacy

R_{33}: If we do the ring and the cover what can we use to protect the water?

I: It is the water guard.

R_{33}: Are we going to pour it inside the well?

I: No, you will use it on the water that you fetch out for use.

R_{33}: Okay, I will buy one for my use

I: If it is that I saw you the last time I came, I told that sister. (Photographer) that if she buys it I will take sample from the water that she used it for, test it and bring the result so that you can see the effect of the chemical on the water.

R_{33}: Any house which is not a flat is difficult to manage. I will try and explain to others when they come

I: I will come back in another four weeks time to take sample from your water if you have started using this water guard and bring back the result. I will also want to see any of the steps that you have taken. What is your name?

R: Dare

I: Oluwasanya is my name.

I: We can't put it inside the well but we can put it in the water meant for individual usage.

R_{32}: Is it after 30minutes?

I: Yes after 30minutes you can use it to bath, cook and wash.

R_{33}: I do not drink the water and since I am using anti-septic soap to bath I don't know if it is useful for other things. But we will buy it

R_{32}: She said we can get it at precious

I: Yes I bought this at Precious Pharmacy; it is just N80.00 I will give you another one month after which I may not be able to come again

R_{33}: Okay.

I: Please tell everybody in the house.

R_{33}: Okay.

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I: What do you use this water for?
R_{34}: Washing of clothes & plates but we don't drink from it.
I: Do you cook with it
R_{34}: Yes
I: What water do you drink?
R_{34}: Tap water
I: Daddy do you have public tap in the house
R_{34}: Yes, he has
I: Will you allow us to take some of the water for sample?
R_{34}: The water is not flowing now
I: What about the one that you have stored?
R_{34}: Okay
I: So you don't drink from it but you cook and wash with it?
R: Yes
I: Do you dry the plates after washing?
R_{34}: Yes
I: How do you dry it?
R_{34}: I use towel to dry it after wash
I: Why don't you drink well water?
R_{34}: Because we know that it is not good for drinking from the hygiene aspect of water
I: How do you know it is not hygienic for drinking?
R_{34}: I know that well water is not good for drinking
I: I am interested in that knowledge, how do you know it is not good for drinking?
R_{34}: I did agricultural science. I know what rain, well, and tap water is. I know the difference
I: Do you think rain water is better than well water?
R_{34}: Yes, I think so
I: So you could drink rain water but not well water?
R_{34}: I know that rain water is better than well water
I: If you want to improve the well water to make it drinkable what will you do?
R_{34}: If it is borehole that's better and different
I: What makes borehole different?
R_{34}: They dug it deep
I: Can you make the well deep too?
R_{34}: It can be done but look at how they wash clothes here
I: So you think borehole water is better than well water?
R_{34}: Yes
I: If they ask you to try and make this well water drinkable what will you do?
R_{34}: In case of borehole I know that they use pipes to draw the water out
I: Why is the borehole water down there better than this one?
R_{34}: This one has no protection, no cover, it is not dug deep
I: Is the well water not from the ground?
R_{34}: It is from the ground but it is not pure
I: So you do not think the well water can be improved upon to be drinkable?
R_{34}: May be if they bring machine and dig it down and cover it like borehole
I: So you think it is only in the conversion
R_{34}: Yes
I: How clean is the tap water?
R_{34}: It is good, it comes from pipe, but I still boil the one that I want to use
I: Why do you boil it?
R_{34}: Because of diseases like cholera and for personal protection
I: Where do you think the tap water comes from, is it from rain water, ground water or river water?
R_{34}: It comes from the water board
I: Where does water board get their water from?
R_{34}: I don't know but I think they pump water from river or dam into the water board and give it good treatment

I: Do you know how they treat it?
R_{34}: I don't know how it is treated
I: Are you the only one using the well?
R_{34}: No, people come from outside to use it
I: If I try to convert the well into a borehole will you use it?
R_{34}: Yes
I: But what about if we change the cover and try to make it more hygienic?
R_{34}: If you put a cover; are you going to pump out the water that is there or how are you going to do it? If you leave the water there and cover it without doing anything to it you will still get the same water
I: Is the water level low or high now?
R_{34}: It is lower now
I: Does it dry off some times?
R_{34}: Yes
I: Do you go to hospital at all?
R_{34}: Yes, when I am sick
I: When was the last time you were sick?
R_{34}: The last time I had malaria
I: When last was that?
R_{34}: About two months ago, around March
I: Apart from malaria what other type of sickness have you had?
R_{34}: My sickness is malaria I have it often
I: And the family too?
R_{34}: No
I: I appreciate what you know and told us about water. You are correct that the public water supply is from the river and it passes through treatment before they are supplied. Ideally they are supposed to be good water but you can't really be too sure.
R_{34}: At times the water has colour due to the chemical used to treat it and that is the problem of public supply. The initial or first water when it is comes you can see the colour.
I: How do you treat such water?
R_{34}: I boil it
I: For how long?
R_{34}: It depends on the quality of the water
I: So you also do some sort of household treatment on tap water?
R_{34}: Yes
I: I am of the opinion that if you stay with your well and treat it as you have said, at the end of the day it will still solve a lot of problem you are facing on public water.
R_{34}: If I have my own well, I will prefer borehole; that's my taste (or class or social level)
I: If we tell you about how you can improve the well will you be interested?
R_{34}: Yes I will be interested because if there is anything that can protect me and others I am interested.
I: Based on that I will tell you that ground water is a good water source. The difference between borehole and well is that borehole is deeper. The major problem that shallow well has is contamination from sub-surface and outside. If there is ring now it can block off contamination from the ground and if the surface here is properly done: if you ring the inside and the ring comes up and then put a proper cover and you use only one bucket to draw water so that when people use it they will, put it back in the well and close it up. By that you can minimize contamination and to compliment all that you can now use water guard on the water you have drawn.
R_{34}: I can agree with you but if we tell the Landlord this water is not good, he will not do anything.
I: Is the Landlord living here?
R_{34}: No
I: You are the one living here and using the well can't you call yourselves together?
R_{34}: It is not possible
I: I understand that it is not your water because you are not the owner but you use it any way and since you use it, you and not the landlord is been affected by the water….
R_{34}: Yes it's not affecting the Landlord
I: Then are you going to do something about the well?

R_{34}: Do you people want to help us to repair it?
I: It is the same thing I said about the Landlord. We do not live here, so it is not our responsibility to do anything, it is you the users, and shouldn't you be able to repair it?
R_{34}: I can not agree who will pay and repair water for the landlord?
I: Does everybody see repairing of well as the landlord's duty?
R_{34}: Yes, I ask someone to contribute to repair light (electricity) and he told me that there is no electricity in the village, he can do without electricity!
I: If we tell government that the water that people use is not good what will be your reaction to that?
R_{34}: The government of today that I know I am very sorry.
I: Sorry that they will monitor it or will not monitor the wells?
R_{34}: They will not monitor the wells. They do not provide us with water, how would they now say we should not use the one that we have?
I: What about if they use a task force?
R_{34}: They won't try it.
I: So you don't think that involving the government will work out?
R_{34}: It will not work out; it is only if they provide the water that they can say this is how you are to use it.
I: There is implication for the usage of this water; since you cook, bath and wash your cloth with it, it is only drinking that you are not using it for. You will need to make it safe because you can not be too smart with the usage if we must use it at all. If I may ask, do you take extra care to remove the remaining water on your plate before you use it to serve your food and if you don't do that, that means you still take in the water and if that is the case people should do something about the well water.
R_{34}: I will talk to the people.
I: You already know about household treatment. You can encourage the others
R_{34}: I will try
I: Please tell others about it
R_{34}: If God provides the money I can personally do it myself
I: The individual can apply the household treatment.
R_{34}: How much is it?
I: It is N80.00; a capful will treat a 25l jerry can.
I: What is your name sir?
R_{34}: My name is Mr. Gabriel

Sample number: OMD 2; Group 2
Well location: Araba's Compound, Omida, Abeokuta
Interview dates: 23/05/07; 20/06/07; 17/07/07

Respondents' profile:

R35
Sex: Male
Age: 57 years
Occupation: Traditional medics
Formal Education level: Primary
Well ownership status: Resident user

R36
Sex: Female
Age: 70 years
Occupation: Trader
Formal Education level: None
Well ownership status: Source owner

R37
Sex: Female
Age: Not obtained
Occupation: Not obtained
Formal Education level: Not obtained
Well ownership status: Resident user

R38
Sex: Female
Age: Not obtained
Occupation: Not obtained
Formal education level: Not obtained
Well ownership status: Resident user

Interviews:

I: Good morning
R_{35}: Do you want to count us?
I: No, we came because of the well water
R_{35}: Come in
I: Thank you sir. We came a while back to sample the well water. We are back now to give you some feed back and to have some discussions with the owner and users of the well.
R_{35}: To give us feed back
I: Yes and we need to speak to those who are using the water to find out the possible causes of the water problem.
R_{35}: My opinion is that when rainfalls, erosion might enter into the well
I: The last time when I came I ask why it was not covered and now I still met it uncovered.
R_{35}: People are still fetching for watching (laundry) and other things when they are through they will cover it.
I: If it is been used for laundry and dish washing the water might still be in the plate when food is served with it and when we bath we cannot be too careful either.
R_{35}: What are the steps we can take now?
I: Well you are the one that owns it, so you should tell us what you think you can do
R_{35}: No, we are together to enlighten ourselves.
I: It's true sir.
R_{35}: Yes what you know we don't know it.
I: From what I can see, a good cover will be needed for the well and it might be necessary to fix a lining. The toilet seems far away enough but that grave site is too close o the well. Then the drawer may be restricted to one for the well and finally you can get one of this chemical – water guard to treat the water before you use it. Now that I have enlightened you what to do, what are you going to do?
R_{37} It is mummy that can answer that because we are tenants here, I listened because I am using the water and I can explain better to mummy
R_{35} How much is the Water Guard?
I: ₦ 80.00 and you can use it for a month.
R_{35}: I too will benefit from this.
I: Am using this as sample to people.
R_{35}: Okay thank you.
I: Sir, what is your name?
R_{35}: Is it necessary?
I: We are doing this to show that we talk to different categories of people.
R_{35}: Am around 30years

I: I can see that you are more than that sir
R_{35}: Why are you asking about age?
I: As I have told you, it is to show that we speak to people in different age groups. What is your occupation?
R_{35}: Herbalist; Traditional Medicine
I: And your educational level?
R_{35}: Elementary Six
I: Mama I have explained some steps to make this water better and I asked how quick it will be done but he said he is a tenant and that you are the one who can answer better.
R_{36} What sort of steps
I: Because of the dirt that enters the well either from under the ground or surface, we suggest that you should put ring lining, cemented flooring and drainage round the well and use only one bucket to fetch the water. I will give you 4 weeks before I come back again and I will see which of the improvement measures you have done.
R_{36} All you have said are good it is for our good but all you have said ₦ 100,000 cannot do it. The rings, cement and cover all is money, and I can not say I can do it in a month
I: What about the Water Guard, it is just ₦ 80.00
R_{36} That's alright maybe we should buy one for the use of all
R_{35} No everybody will have to buy his own.
I. I will leave a month interval before I come back
R_{35} Thank you very much
I: Yes Sir.

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I: Were you at home when we came here the last time? Do you know about what we ask you to buy for the treatment of your water?
R_{37}: Yes
I: have you started using it?
R_{37}: No
I: Why? Did you forget, or it's too expensive?
R_{37}: No, is it not N100.00?
I: It's N80.00; and it's over a month now

I: Well done Ma, did you buy the water guard?
R_{38}: I was not at home when you came
I: Did nobody tell you about it?
R_{38}: They told me that it is available at Precious
I: So, no one bought it, my thought is that I will take sample of your treated water today for examination and bring you back the result again.
R_{38}: When are you coming back?
I: In another four weeks time
R_{38}: We would buy it before you come again but we are not drinking the water.
I: This is what we are trying to explain to you, the water you are using for cooking, washing of plates even bathing of babies is as good as drinking. One woman said also she is not drinking but she put her baby in a water basin to bath him, she went in for something and before she came out the baby has been drinking the water.
R_{38}: Small children don't know anything
I: I see. On the next visit, I will come with one of my supervisor.

I: Good morning Sir
R_{35}: Good morning
I: Daddy, people say you don't give them our message
R_{35}: Who said so? We will buy it, we have all heard about it.
I: I was telling mummy now that next month when I visit again that I will come with my supervisor, she will want to ask you some questions.
R_{35}: We will answer her, no problem about that, we are not afraid of that.
I: The water level has not risen up very much
R_{35}: It has been fetched; many people came this morning to fetch it.

I: Please tell those who are fetching the water to buy the water guard and use it for their water
R_{35}: We shall buy it; if you have it, can't you sell for us?
I: I don't sell it, but they have it at Precious Pharmacy, if am selling it now people might think that is why I came out, and that is not my own work.
R_{35}: Okay, write the name for us.

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I: I spoke with you so that you can improve the well; you even fail to buy the water guard.
R_{37}: We didn't buy it because we are not using it to bath
I: What about your children?
R_{37}: We don't use if for them either we fetch tap water or from the deep well over there

I: Good day Ma
R_{36}: Good Morning
I: What we ask you to buy the other time did you buy it?
R_{36}: We didn't buy it; we've abandoned that water for another
I: Which water are you fetching now?
R_{36}: The former one that we are using before. We have been unable to buy the chemical
I: Why have you been unable to buy it?
R_{36}: We would buy it
I: Will you be able to buy it at all if you are unable to do so within three months?
R_{36}: We would buy it. It is for our benefit
I: Mummy when did you visit a hospital last?
R_{36}: It has been a long time
I: Is it up to a year or months?
R_{36}: About three months ago
I: What happened to you then?
R_{36}: I have pains in my leg
I: What about your children, when do you take them to hospital last?
R_{36}: Not at all
I: Mummy, it seems you are not willing to do anything to this well
R_{36}: We would try it. It's only that the money is not available now

I: Good day aunty
R_{37}: Thank you
I: Your child has stopped teething?
R_{37}: Yes
I: What was the problem he had?
R_{37}: He had temperature and he was stooling
I: When last was that?
R_{37}: About 2 months ago
I: Which drug did you use?
R_{37}: Bonababe
I: Who ask you to use the drug?
R_{37}: It was advertised on the Television?
I: It is not prescribe by a doctor?
R_{37}: No
I: Does the drug work after use?
R_{37}: Yes
I: Has it happened again?
R_{37}: No
I: How frequent was the stooling?
R_{37}: Like twice in a day
I: What type of water are you using for him?
R_{37}: Tap water
I: Did you add anything to the water?

R_{37}: No
I: Do you bath him with well water?
R_{37}: No
I: What about when tap water is not running?
R_{37}: There is a well over there better than this one
I: How do you know that it is better?
R_{37}: It is good, we all use it
I: You said good, is it in terms of construction?
R_{37}: Yes
I: Did they put rings in it?
R_{37}: I cannot say
I: Do you use your drawer there or they have a dedicated one?
R_{37}: They have a drawer there
I: When last does the tap ran?
R_{37}: This one is spoiled we fetch from the one at main road
I: Has the tap run this morning?
R_{37}: Yes
I: Is daddy not allowing you to fetch water from his well? (Referring to a neighbour's well)
R_{37}: He allows us
I: Do you prefer this one
R_{37}: No, we fetch from both wells
I: Have you bought the chemical?
R_{37}: We would buy it.

I: Good morning sir
R_{35}: Good Morning
I: Did you buy what we asked the last time?
R_{35}: No, I have not; I can't tell a lie
I: Why?
R_{35}: I am going out today I will surely buy it
I: But you have not bought it in the last 3 months?
R_{35}: I always forgot to buy it.
I: When was the last time you went to the hospital?
R_{35}: It is a long time
I: Have you had any cause to go to hospital recently?
R_{35}: I am supposed to go this month because of my condition
I: What condition is that?
R_{35}: I had fracture in this leg
I: You do not have headache?
R_{35}: I am alright
I: So you don't have fever?
R_{35}: Everybody has fever but it has not been serious to warrant going to hospital
I: What type of fever did you have before?
R_{35}: I am a native doctor, so I always protect myself from sickness and fever attack.
I: Do people come to you for treatment?
R_{35}: Yes, but am based at Lafenwa
I: Those that visit your traditional clinic what do they complain of?
R_{35}: Pile
I: What other type of sickness do they complain of?
R_{35}: Fever and I have treatment for body itching
I: Do you treat people for diarrheal?
R_{35}: Yes
I: What type of medicine do you use to cure diarrheal?
R_{35}: We use herbs; we mix different herbs together
I: Do you have the herb mix now?
R_{35}: No, I prepare it on request
I: Those who request for it, are they many?
R_{35}: It is a minor thing

I: But do people come for it?
R_{35}: It is not common in our area here
I: If they are counted they will be up to how many in numbers?
R_{35}: They are many
I: Are they young or old?
R_{35}: Both
I: What about people who came for typhoid?
R_{35}: That one is common. They are many
I: Like how many people come for typhoid treatment in a month?
R_{35}: Like 3 or 4 people in a month
I: This household is about how many people?
R_{35}: We are many
I: Like how many families?
R_{35}: About six, each with his children.
I: Each family comprises of about how many people?
R_{35}: I don't know, I can't tell you that one unless you call others in the house
R: I have visitor now, can you release me.
I: Yes, thank you

Sample number: OMD 4; Group 2
Well location: Sagbami's Compound, Omida, Abeokuta
Interview dates: 23/05/07; 20/06/07; 17/07/07

Respondents' profile:

R39
Sex: Male
Age: 60 years
Occupation: Bricklayer
Formal Education level: None
Well ownership status: Source owner

Interviews:

I: The result shows that the well water has some disease causing bacteria and we'll need to talk about what to do ……
R_{39}: It is not that we drink the water; we just use it for domestic works
I: Do you use it for cooking?
R_{39}: Yes
I: Don't you think the water can get into your body system through that?
R_{39}: So it can cause illness like cholera?
I: With what we found from the test, yes
R_{39}: What is the cause of such germs and what can we do?
I: From what I can observe, your toilet may be one of the causes because the location is too close to the well. So for toilet water not to get into your well, you may need to fix lining to the well to prevent movement of water from the toilet into the well and maybe also stick with the usage of one drawer
R_{39}: In that case, I am a bricklayer; I will get the rings and raise it. I was actually hoping to relocate the well to another location further down. What you are doing by testing the water is not for the government but for us. You know that when there is health, there is wealth. You can take the sample and test again while I get the alum and salt to kill the bacteria.
I: I have something here to show you. It will help in removing the contamination. Please, can we have the key to the well?
R_{39}: Yes, you can

R_{39}: This is alum from the Water Works
I: Daddy, the work of alum is to cause the dirt in water to settle down
R_{39}: What about the work of salt?
I: Salt can not kill the entire virus in the water. Water works uses alum because they are using river water. The water involved at Water works level is enormous. They also use chlorine, the content of this water guard too….
I: This is the water guard. It is used to treat water from contaminations. This is a sample for you to recognise it in the shops or pharmacy when you go to get one. A capful will treat 25 litres of water. Do you understand my explanations?
R_{39}: Yes
I: The instructions are also on the bottle
R_{39}: Can this type of container work for it? (Showing us a bucket to get what 25l size is)
I: It depends on how many litres it is. I think it is better to get a 25 l jerry can and just use that anytime you want to apply the treatment
R_{39}: Ok, I have one inside. We use it to get and store drinking water from the tap. So, we can buy this water guard and pour it inside the well.
I: This one has been diluted for household use. At water works they use the undiluted one because of the volume of water they are dealing with. The difference to well water is that well springs continuously therefore it has no fixed volume per time. That is why this smaller content is made for household usage.
R_{39}: Can we not pour it into the well directly?

I: No, the water in there will be too much over time unlike water works where they treat fixed amount of water volume which enable them to know the amount of chlorine to use.
R_{39}: What about their big reservoir do they know the measurement?
I: Yes they do, everything is first designed on paper.
R_{39}: Is this chemical only applicable to well water?
I: No, you can use it for any type of water
R_{39}: can we use the water for drinking and cooking after application
I: Yes, you can use the water for anything after application
R_{39}: Do you work for Water guard?
I: No, I don't. Water guard is part of what I use for my work
R_{39}: I will fix the ring but the water is really rising up every day now it will have to be done during the dry season.
I: Yes, it is true. Let's measure the water level.
R_{39}: How many feet?
I: About 2.8ft……..If the water is dirty I would have suggested alum
R_{39}: I don't allow people to even come close with their shoes. I put a lot of restrictions on people who fetch the water. My concern now is that with all I am doing my well is not better than those that they don't take care of.
I: If I need a representative now it will be easier to pick you because you have been managing your well and eager to make your well better. So, I think you are doing a good job
R_{39}: I have paid part of the money for the ring I want to use for the other well.
I: This chemical will treat and kill the germs
R_{39}: I will buy it, how much is it?
I: N80.00. You can get it at Precious pharmacy
R_{39}: Even if it is N100.00 naira, it is worth it
I: You may be able to use it for a month depending on how much water you use
R_{39}: That is good. With the price I should be able to get three at a time. I hope it doesn't spoil
I: No, it doesn't. I will take the water sample from the well now and bring the result later to see whether the salt and the alum really worked.
R_{39}: The reason why I put alum is that I cannot say whether the water is clean enough or not.
I: Try and use water guard. I'll come back in a month's time to take the samples of the well and the treated water to see if there will be any changes or difference
R_{39}: Is there a bigger size?
I: No
R_{39}: Ok, I will keep the well safe. I know that it is important to keep the well clean. I used to do it like that but the people around are very wicked. They broke the cover and damage those things. I was even telling someone some days back that I am yet to get the result from you. I thank God that you showed up today. I plan to get the rings but it as to be during the dry season. As you know we have to get the water out before we can do that. It will be easier that way for those who will work on it. They will also get the dirt out (re-dig). So, we will wait for four weeks before we get the results
I: Yes
R_{39}: Ok, neatness is my topmost priority. We do not have to be told before we do it. Like this morning, I had to cut down this tree because it breeds insects. It is our safety
I: That is true. I will also advice that you cement the well area so that this place will not be muddy
R_{39}: Yes, I have done it once, but it was not well done
I: Ok
R_{39}: I'll try and get the chemical even if it is not up to the three I mentioned. I know it is essential now
I: Yes, I think so too

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R_{39}: We were at home the time you came but we were not notified of your presence.
I: Ask your child to bring us the key.
She said your well is good and ask whether she can take a photograph of it
R_{39}: Yes, she is free to do so. You see the alum is working. It works
I: Yes, I know it does, but daddy the work of alum is to make water settle

R: What is the work of the salt then, is it not to kill the germs?
I: It works but it does not kill the germs. We brought a chemical to you the other time, do you remember?

Sample number: LFW 3; Group 2
Well location: 11b, Abule Otun, Lagos Road, Lafenwa, Abeokuta
Interview dates: 23/05/07; 26/06/07; 18/07/07

Respondents' profile:

R40
Sex: Female
Age: 40 years
Occupation: Trader
Formal Education level: Primary
Well ownership status: Resident user

R41
Sex: Female
Age: 66 years
Occupation: Retired food vendor
Formal Education level: None
Well ownership status: Resident user

R42
Sex: Female
Age: 27 years
Occupation: Trader
Formal Education level: Secondary
Well ownership status: Resident user

R43
Sex: Female
Age: 27 years
Occupation: Trader
Formal education level: Primary
Well ownership status: Resident user

Interviews:

I: I was talking to some people from the other house they said they are not drinking the well water but use it only for washing, bathing and our understanding is that we drink any water which is used for cooking or washing of plate. As it is now a toilet is over there and not having a cover even made it worse. Also multiple drawers is been used and look at how dirty the well area is

R_{40}: See, the construction was done recently. The people of this neighbourhood just derive pleasure in destroying things. The other well there has a lock; I kept the key to myself. But this other well, there is nothing we can do; our neighbours here fights me over the well that's why I left the well unattended to.

I: We cannot run away from water we only have to take good care of it. We also can not keep the children away from water as well. If you can do anything, it will be good to fix the rings, raise it above the ground level since it is not deep, 2 rings will do and the third ring will be above the ground and that will enable you to have cover on it. About the drawer, a dedicated bucket can be tied to the cover so that it can drop inside the well and whoever needs water will open the cover, use the drawer, drop it back and close the cover back again….

R_{41}: Sorry that I am cutting you short, what you are suggesting is good but the people here will not accept what you have just said. It has been war over the well. With all what we did the other time the well was repaired, they made it very difficult for us and insulted us throughout. A woman once told us that 'we are the ones using the water for cooking, she only use the water for laundry'; they never agree on something good in this area.

I: I understand, but take the comment from the woman that you referred to, she told you what she believes, but as you said you use the water for cooking. Obviously you need to take better care of the well. God will protect, but we also need to be vigilant with this

R_{41}: The caretaker's wife did a lot when we complained about their hygiene but they destroyed everything. There was a situation back then, which resulted because I scolded a child for being dirty with the water, he went and called his father. The old man opposite called me a crazy woman and I had to ask him to stop insulting me. I explained that my concern for the well is for everybody's benefit and not only for myself, but they do not appreciate it. This other woman too takes everything negatively. She once told me that 'where are the well owners, are they not all dead' (implying that you don't need to kill yourself over what you do not own)! I am sorry but on the case of this water, I do not guarantee its safety in my hands. The insults are too much and think of the fact that it is for their safety

I: If someone told you that she is not drinking it and she picked a drawer from a dirty place like toilet and put it directly inside the well won't that cause problem for other people? So it is the people who own the well that will try and manage it. God forbids a situation where there is an outbreak of disease.

R$_{41}$: There is no problem, may be we would sand fill the well and close it up. Everything used to be ok but they destroyed it. When our landlords repaired the cover they have spoiled it again. And this is their only source of water when there is no public water supply. You will see how people queue up to fetch water until they fetch it dry.
I: Why are your people behaving like that?
R$_{40}$: I don't know. They always abuse us if we complain of their bad usage. But at the other well no one dare do rubbish. The well that I have a say on, I do take care of it. If you go there now it's under lock but this one is not within my power/supervision anymore.
I: I checked that well the last time I came and it is alright that's why I am not going to go there today.
R$_{40}$: I don't allow anybody to misuse that one, I am using it and so I can't allow any one to spoil it. I don't know what we can do even though it is useful for them.
I: If it is useful for them then the only thing is to take care of it or is it because they have other wells around?
R$_{40}$: It may be so. But I know that everybody knows that I have tried in getting them to do the right things about the well, but they do not comply
I: What about the owner, should he not be responsible…….
R$_{41}$: The owner is dead
I: Is there no one who can take responsibility for the well?
R$_{41}$: The only person who used to be in charge after the death of the owner are the traders in the shops opposite us, but she is also dead and the shops have been taken over by new tenants. We the residents are supposed to look after the well now
I: So can't the resident users agree on taking proper care of the well?
R$_{41}$: At all; the people of this neighbourhood do not agree on anything that will benefit them
I: Ma, please do you have well water stored in the house?
R$_{40}$: Yes, I will get some for you
I: In other words, the demise of the well owner gave room for people to mess things up
R$_{41}$: I once called the owner to come around to look at the well. They made a cover and they destroyed it. They made another but they also destroyed it. The last cover was very recent, you can see for yourself, its destroyed. We covered it and place a lock on it but they claimed that it not good as the keys were kept only with me. So we gave the keys out to them. I have one, the outsiders have one and the neighbour's retained the last key. This place is like a market. The owner passed the well up to her shop to cook with, everything was neat back then and the pit latrine was not constructed then.
I: How many years ago was this?
R$_{41}$: It should be like 20 years. The when the well needs repairs, the owner's brother will climb inside the well to clean out the dirt and yet they won't stop messing it up, it's so frustrating. I will take necessary actions on the well that I have a say on. Let me give you another example. When you saw me this morning trying to sweep and tidy the well area, it is not that I knew that you were coming to inspect the well. It is just something I have made my responsibility. The well owners did not expect all this. I have lived here for a long time. I left at some point and came back. My children complained that the house is not as good and neat as I left it because of the careless use of the residents. Just yesterday again, I did thorough cleaning and this morning the whole place is all mess. My children will not be happy meeting me here and I will be ashamed to say this is where I live. Before I swept this place this morning, you would have asked if people that live here are able to sleep. A relative of the owner came around sometime ago wondering why the whole area is left un-kept. I told him that I purposely left it for him to see. You will find excretes and urination almost everywhere. I even try telling them that the situation is affecting my health, but no changes. I like this house, I've lived here for a very long time and I do not want to leave, but they are not helping matters. To make our surroundings clean is something that we want, I take it as my job to do so. We were taught to wake up in the morning and clean our surroundings and we do so, but nowadays, some people just live in the house, they even claim that they can not sweep, pride that will not get them anywhere..
I: So, there is no way that you can agree on this
R$_{41}$: No way
I: What about the caretaker that collects the rents?
R$_{41}$: The caretaker who used to live around is gone….can you see the woman who just passed bye, they made this place dirty…….if I sweep they will insult me and if I do not, my children

will not like it. Most of my children are married; they will come here with their wives to tell me that where I live is not neat enough and may ask me to move out

I: Do you also use the well water?

R_{41}: I fetch it but I get tap water too for use. I do not drink it though; I only use the well water when there is no tap water

I: If you would not be able to do more than this. There is a chemical that those who wants to use the water can use to treat it, it is called Water Guard it kills water germs.

R_{41}: Where can we get this?

I: It is in all Precious Pharmacy stores, one capful of it treats 25liters of water and it is sold for ₦ 80.00. I will come back after 4 weeks so that I can take the sample of the water you've applied the chemical to.

R_{41}: I only use well water for washing my cloths. We do not use it for anything that involves the water getting into our body system

I: Try to get one for yourself

R_{41}: Please write the name for me, I will surely get it

I: Would you be available when next we come around?

R_{41}: Yes, by God's grace

I: Ok ma, what is your name?

R_{41}: Deborah Lawal

I: How old are you?

R_{41}: I can't say I had some problems with my parents at birth…..

I: How old is your first child?

R_{41}: My first child is 28 years old

I: What work do you do?

R_{41}: Nothing precisely, but I use to trade

I: Do you have any form of education?

R_{41}: No

I: Thank you

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I: What do you do when the children are sick?

R_{42}: We take them to hospital

I: Which hospital are you using?

R_{42}: Iya Abiye in Adedotun

I: Is it traditional or orthodox?

R_{42}: It is modern but they practice native medicine there also

I: When last did you visit the place?

R_{42}: My children are grown up now; we go there now for pre-natal treatment.

I: What about yourself; why didn't you go their except for pregnancy?

R_{42}: I do go but only when I have diarrheal; but not often.

I: Oh you had diarrheal, when last was that?

R_{42}: About a year ago.

I: What do you think causes diarrheal?

R_{42}: They said it is something about the state of my stomach and when I eat beans, I have such problem.

I: What about your children, do they have the same problem when they eat beans?

R_{42}: Yes, but he was treated and I was to give him beans regularly.

I: When last was that?

R_{42}: About six months ago

I: Do you remember the name of the drug you were given?

R_{42}: I have forgotten but it is whitish in colour

I: What drug did you use when you had diarrheal?

R_{42}: It is a tablet white in colour

I: Do you know its name?

R_{42}: No

I: Is it Flaggy?

R_{42}: No, Flaggy is Yellow

I: What do you do with this well water, do you bath with it?
R_{42}: Yes, when there is no tap water
I: Where is the nearest tap to you?
R_{42}: Down there
I: Is it running now?
R_{42}: No
I: Why don't you cover the well?
R_{42}: It's our people; some of them are bad, they broke the cover; that's why we stop using the well water for cooking and bathing.
I: But you use it for cooking

A respondent introducing us to her neighbour:
When this sister first came she asks us why we are not using the well water for cooking and we said because it has no cover and it is close to the toilet. Later she returned and said that the water has Cholera. Even if that is true, may God help us! This is the water that we are using for washing (laundry) and bathing. I bath my child with it this morning.
I: Is that so?
R_{42}: Yes
I: And Mama didn't tell you there is something that you can use to treat the water?
R_{42}: No
I: What we said is that the water is not good but if you use this water guard the water is safe for use. What is your name?
R_{42}: Mrs. Modupe Adedeji
I: What do you do for a living?
R_{42}: Trading
I: What is your educational level?
R_{42}: S. S. 1
I: How old are you?
R_{42}: 27 years

I: Aunty, did you get the chemical we asked you to get on our last visit?
R_{43}: Yes, we did
I: I will like to collect some of it for testing
R_{43}: Are we to apply it to the water? We thought it was only for bathing water
I: No, it's applicable to anything you want to use the well water for
R_{43}: We applied it as instructed. You should explain the usage of the chemical well to Mama (referring to Mrs. Lawal, R_{41}) because we are not always here
I: Did you taste the treated water?
R_{43}: No, no one did
I: Ok, what is wrong with your child?
R_{43}: my child? Nothing, there is nothing wrong with him
I: We heard that he is teething
R_{43}: Yes
I: What did you use for him?
R_{43}: We took him to the hospital, Duro hospital; it's very close to this place
I: Which drugs were you given?
R_{43}: I don't know it
I: Is it Bonababe?
R_{43}: I don't know.
I: What is your name Ma?
R_{43}: Mrs. Kehinde Owolabi
I: What do you do for a living?
R_{43}: Trading, I travel with goods
I: How far with formal education?
R_{43}: I did not go far, I stopped at primary 5
I: How old are you?
R_{43}: 27 years

Sample number: LNT 1; Group 3
Well location: Opposite Sacred Heart Hospital, Lantoro, Abeokuta
Interview dates: 24/05/07; 27/06/07; 17/07/07

Respondents' profile:

R44
Sex: Female
Age: 60 years
Occupation: Trader
Formal Education level: Primary
Well ownership status: Source owner

R45
Sex: Female
Age: Not obtained
Occupation: Food vendor
Formal Education level: Not obtained
Well ownership status: Resident user

Interviews:

R_{44}: Explain what we are to do or how they are doing it to us. We've just dug the well when the water problem was getting too much.
I: I saw that you are just working on it the last time I came.
R_{44}: We made it to prevent water problem - scarcity
I: I want to introduce a chemical to you, it kills water germs.
R_{44}: How much is it?
I: I bought this for ₦ 80.00 at Precious Pharmacy as a sample; the direction for usage is on it.
R: Where can we get it?
I: You can get it at Precious Pharmacy. One is at Omida, opposite Olubara Palace, Adatan and Abiola way. I bought this at Omida store
R_{44}: Let us buy this one and you can go and get another.
I: I am moving round Abeokuta and am using this as a sample

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I: When last were you at the hospital?
R_{44}: Long time ago
I: How long is the long time?
R_{44}: 21st of April 2006
I: That is last year
R_{44}: I've been there this year too
I: What happed to you then?
R_{44}: I went for check up.
I: Oh, not because you are sick?
R_{44}: No
I: Did they prescribe all these drugs for you in the hospital?
R_{44}: Yes
I: What about the children, why did you take them to the hospital?
R_{44}: It is either for cough or when they have malaria
I: Do they have diarrheal?
R_{44}: No, except our footballer who sustains bruises when playing ball.
I: How long does this take to heal?
R_{44}: Not long
I: Are you bathing with this well water?
R_{44}: Yes
I: When the wound heals does it leave scars.
R_{44}: Yes, but if the water is clean there will be no scars, the wound will heal well
I: Did you tell others to use the water guard?
R_{44}: Yes, are you selling it?
I: No, it will be better you buy one from the Chemist. You can decide to be selling it as well. You can display it like you displayed the rob menthol, people might be eager to come to your shop to buy than going to the chemist

R_{44}: I will think about it
I: Lastly, what is the difference you noticed when you used water guard?
R_{44}: It is good but only it should not be over used.

I: Are you using this well water?
R_{45}: Yes
I: When was it that your child has teething problem?
R_{45}: He has not started (baby under three months old)
I: When your children are sick do you take them to the hospital?
R_{45}: Yes
I: What sort of sickness?
R_{45}: Fever
I: Is it often?
R_{45}: No
I: Do they have dysentery?
R_{45}: No
I: Thank you, good bye

Sample number: SKN 1, Group 3
Well location: Sokenu's Compound, Kolade Street, Oke-Ijeun, Abeokuta
Interview dates: 24/05/07; 27/06/07; 16/07/07

<u>Respondents' profile:</u>

R46
Sex: Female
Age: 73 years
Occupation: Trader
Formal Education level: None
Well ownership status: Source owner

R47
Sex: Female
Age: 42 years
Occupation: Trader
Formal Education level: Secondary
Well ownership status: Resident user

R48
Sex: Female
Age: 49 years
Occupation: Trader
Formal Education level: Primary
Well ownership status: resident user

Interviews:

R_{46}: I have been thinking that you are not coming again
I: I told you we would come back
R_{46}: Before you arrive, I have made up my mind that I will fix the rings in the dry season because then the water level would have gone down.
I: It will be better when you fix the ring, you can also try and make a cement pavement round the well to prevent stagnant water at the base of the well.
R_{46}: We have done the pavement before it was those who are hoeing this area that destroyed it. We also monitor people who wash there. I will buy the chemical that you introduced, you can write the name for me.
I: Yes, I will write it for you.
R_{46}: Are we going to dilute the chemical before we can use it?
I: No, you don't dilute it, the instruction is on it.
R_{47} We do not drink the well water
I: Do you use it to wash cloth and plate?
R_{47}: Yes we even cook and bath with it.
I: That's the problem if we are using it for cooking and bathing such water should be considered as being consumed.
$R_{46:}$ She said the water has cholera and she is asking us what we can do.
$R_{47:}$ You can tell us what to do
I: May be your toilet is not deep and some other toilets around.
$R_{46:}$ Our toilet is deep but we can not say of others.
I: What we can do is, like she told me earlier, to fix rings inside the well. You can also attach just one bucket to the well and let it be a permanent one that will prevent people from bringing different drawer to the well. It is also not good as you put your drawer on the bare ground.
R_{46}: It's because of others who may be coming for water that's why we put it beside the well.
I: The cover also has holes and that could allow dirt into the well even when it is closed. I will show you a chemical that you can use to treat water and make it safe for use. I will also have to come back again in four weeks time to see whether you have been doing what we have discussed and also if you've started to use the chemical. I will take sample of the treated water for further examination and I will come back to give you the result.
R_{46}: Can we put the chemical inside the well?
I: No, individual should have his/her own and treat the water that he/she draws for use. Well springs continuously and that will reduce the power of the chemical. One capful of the chemical will treat 25l of water.
R_{47}: After that, can we use the water for everything?
I: Yes, including drinking.

R$_{47}$: Are you from Water Guard Company?
I: No, I told you the last time that I am from UNAAB; I have nothing to do with Water Guard Manufacturing.
R$_{47}$: Are you sure the water will be safe for drinking?
I: Yes, Government also treats river water and supplies it to the people to drink. And this is one of the treatments they put in the water.
R$_{47}$: It is okay then.
I: This is the chemical; I bought if for ₦ 80.00 at Precious Pharmacy Store
R$_{47}$: Can we buy one from you now?
I: I am not selling it. I bought this as a sample.
R$_{47}$: We would buy it when we have the money.
I: I want to take your names
R$_{47}$: We are all Ogunmuyiwas
I: What about education?
R$_{47}$: I did not attend school at all
I: What is your work?
R$_{47}$: We buy and sell, eat and sleep.
I: How old are you?
R$_{47}$: 42 years
I: Thank you. I will come back to see the effect of the chemical on this water; I want to see if there is any difference after using the chemical.
R$_{46}$: Is there a bigger pack of the Water Guard?
I: No, I know about this size alone and it can be used for a month depending on the quantity of water that you are using.
R$_{47}$: We have a 200l drum.
I: Measure 8 caps, stir it and leave it for 30minutes. And also after the treatments make sure you are careful of what you put inside the water.
R$_{46}$: Thank you very much.

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I: Did you buy the water guard?
R$_{47:}$ I've not been able to go there
R$_{48:}$ Nigeria is not easy
I: It is only N80.00. You said you have not been able to go to that area.
R$_{47}$: I can not spend N40.00 on taxi because I want to buy N80.00 water guard.
I: Very interesting! Is it because you are not drinking the water or why are you not showing any interest in improving the well water?
R$_{47}$: I told you I want to buy it….is that why you brought a white person?
Look she ask me to buy water guard and I can not spend N40.00 on taxi purposefully because I want to buy that N80.00 thing.
I thought she was the one selling it if that is the case I can buy from her.
I: I am not a trader.
R$_{48}$: I will love to buy because of our water, I have 200l drum
I: Is it from public water
R$_{48}$: Yes
I: When last does the tap water ran?
R$_{48}$: Two weeks ago
I: So you have storage that can last you for two weeks
R$_{47}$: I still even have some in my jerry cans
I: But you still use well water for other household chores
R$_{47}$: That's why I said I want to buy the water guard. I think of safety but I can't because of N80.00 spend N40.00 on cab; that area is not my route

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R$_{47}$: People are not around now

I: Do you know if any one here has had cholera before ……..
R_{46}: Mummy said God has not allowed that to happen. The public water also has sediment when it settles. At times we don't drink it, we buy pure water but this well water we use it for bathing and washing alone.
I: So none of the kids………….
R_{47}: None
I: Is it none or none in recent times?
R_{47}: None, we have not experienced cholera before.
I: When did you visit the hospital last?
R_{47}: If we go to hospital it is for malaria treatment.
I: Who says it is malaria?
R_{47}: The doctor
I: What did you feel before you went to hospital?
R_{47}: When I start to feel a bitter taste in my mouth or body pains and when I get there they will ask us to do blood test after which they will prescribe drugs for us.
I: So you have not experienced other type of fever before?
R_{47}: We have typhoid
I: When last did you have typhoid?
R_{47}: May be last year
I: Is it up to a year now?
R_{47}: It is not up to a year
I: And the kids too have they been treated for typhoid before?
R_{47}: My first daughter, she is not staying with us
I: Is she staying within Abeokuta?
R_{47}: No, she stays at Ilaro
I: What about Mummy?
R_{47}: This mummy, she complained of body pain when she took one of the grandsons to hospital and just of recent she had malaria
I: No typhoid?
R_{47}: No
I: In our last discussion we talked about improving the construction of the well
R_{47}: The last time you came you know that mummy's major complain is about getting the money to do the repairs. We are gong to do it but not now. People come here because the well is covered and clean sometimes they said that they are drinking it when the is no tap water
I: Have you told those that have been coming to fetch water from the well?
R_{47}: I told them that they can not come with chewing stick around here or do any dirty things around the well and we don't allow them to use dirty drawer.
I: Do they use your own drawer?
R_{47}: We gave them drawer or allowed them to use their drawers if it is good but if it is dirty we told them not to use it. If it is not for the problem of drinking water scarcity we would have locked the well.
I: Like how many people will you say use the well; starting from those living in the house, how many people are here?
R_{47}: Like 10 or eleven people
I: What about the non-resident users?
R_{47}: Around four houses and people from general hospital
I: When was the well constructed?
R_{47}: 1972
I: How old are you Ma?
R_{46}: Above 73 years
I: What does mummy do for a living?
R_{46}: I am not working again
I: What is the name of this area?
R_{47}: Kolade Street, Sokenu
I: Thank you Ma

Sample number: SKN 2, Group 3
Well location: Hassan's compound, Kolade Street, Oke-Ijeun, Abeokuta
Interview dates: 24/05/07; 27/06/07; 16/07/07

Respondents' profile:

R49
Sex: Female
Age: 80 years
Occupation: Trader
Formal Education level: Primary
Well ownership status: Source owner

R50
Sex: Female
Age: 27 years
Occupation: Trader
Formal Education level: Secondary
Well ownership status: Resident user

Interviews:

I: I want to ask you ma because you are the one living and using this well water, what do you think are the causes of this level of contamination?

R_{49}: I am not sure. I know that water is from God but I think that it is rain that makes the place muddy

I: I observe a burial site there close to the well it ought to be about 10 m away, and the toilet as well.

R_{49}: The grave and the toilet were there before the well.

I: The cover also has holes in it and if it rains it will wash dirt from the cover into the well. I also spoke about your drawing buckets. If we know the causes, then to correct it will be easier. Setting rings inside the well will take care of all the germs and dirt's that moves beneath the ground, and the rest will be the hygiene practices.

R_{49}: Yes, all these are essential but it is not something I will do myself. You have to write them down so that I can give it to my children whenever they come around

I: We may not be able to move the toilet or the burial site therefore our attention should be on the well. To do this I brought a chemical that we can use for the water. They sell it in town; it is used to kill water germs. It is just ₦ 80.00 and the bottle can be used for about a month. Depending on how much water you are using. The instruction on how to use it is on it.

R_{50}: Can we use it for the water meant for drinking?

I: Yes, just make sure you follow the instructions, and after treating your water make sure you put only clean things into it to prevent germ and dirt's from getting into it again.

R_{50}: Can we apply it to tap water?

I: Yes, but the government has already put this in the tap water.

R_{50}: Is it meant for only well water?

I: You can use it for any type of water. Mummy has asked me to write other measures to be taken for her.

R_{50}: Are you giving us this pack?

I: No, I brought this as a sample. I will come back in another 4weeks to see how far you have gone in implementing the steps we mentioned. And if you have started using the chemical I will take sample from the water you have treated for further test and bring the result to you for you to see the difference.

R_{50}: Where can we get the Water Guard?

I: It is available in all Precious Pharmacy Stores. And about the drawer (doro) it will be better if the cover is repaired and one drawer is tied to it permanently.

R_{49}: What did she say?

R_{50}: She said all of us should be using one drawer.

I: Since you are all using it, and it is for your benefit, I think you can reach an agreement on all these measures.

R_{50}: For how long should we leave it before use?

I: 30minutes. Apply it, shake it and leave it for 30minutes.

Aunty please come when I'm putting the rings, it raised it above the ground level and put a cover on it make a cement floor round it and with a small gutter to all water to flow away from the well. Lastly, the Water Guard should be used one capful for 25l of water, and only one *drawer tied to the edge of the well and put inside the well should be used. Discussions with a learned respondent to explain further to the old lady – the source owner*

R_{50}: Mummy what she is saying is that the idea of everybody coming with different drawer must be stopped; only one drawer must be used by all.
I: What is your name ma?
R_{49}: Raliat Hassan
I: How old are you ma?
R_{49}: Only God knows that
R_{50}: She will be about 80 years
I: What is your occupation?
R_{49}: Trading.
I: Did you go to school?
R_{49}: I did but stopped at primary three
I: Are you the house owner?
R_{49}: No, it belongs to Hassan my Father in law.
I: Who gave me the water (water from storage)?
R_{49}: It is Iya eleko
I: When did you fetch it?
R_{50}: In the morning
I: Thank you ma.

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I: Good Moring
R_{50}: Good Morning, how are you?
I: Fine thank you, Are you able to buy the chemical?
R_{50}: I went to ask for it but they did not have it in stock again
I: Where was that?
R_{50}: Kuto
I: What about Precious, you did not go there?
R_{50}: Yes (meant no)
I: Did any other person in the house buy it?
R_{50}: No
I: What is the condition of the well now that the rains are here?
R_{50}: I don't drink it but the water level has risen
I: What about mama's children who are supposed to come and repair the well?
R_{50}: They have not come
I: Did any of your children have diarrheal or cholera?
R_{50}: They never have it.
I: Is it that they never have it or it has been a long time since they had it?
R_{50}: It has been a long time, about seven years ago. Tunde had dysentery when he was a child. Is it water that causes it?
I: Yes, water can cause it
R_{50}: When the water is not treated before use?
I: Yes, but when did you take them to the hospital in recent times?
R_{50}: Only when they are sick
I: When last is that?
R_{50}: Probably two months ago
I: What happened then?
R_{50}: He had malaria
I: Is it you that call it malaria or doctor?
R_{50}: Doctor didn't tell me that, he only prescribed drug and injection to be used, but the types of injection shows it is malaria injections.
I: Has anyone had any case different from malaria?
R_{50}: No
I: Do you know the difference between malaria and typhoid?
R_{50}: Yes
I: What about you?

R_{51}: When I feel any headache I take paracetamol. It's only the children that we take to hospital when they are sick
I: How many people do we have in the house?
R_{50}: About 25 people
I: That will be about how many families?
R_{50}: Four families
I: Apart from those who are in the house, how many more people use the well?
R_{50}: I can not say. They are lots of people who come here particularly when there is no public tap
I: When last do you have public water?
R_{50}: A week or two weeks ago.
I: What have you been drinking since there is no water supply?
R_{50}: Pure water
I: You and the children?
R_{50}: Yes
I: So you do not drink the well water?
R_{50}: Yes (meant no)
I: What about others who are fetching the water?
R_{50}: We use it for cooking and washing
I: Do you remember that is the reason why I ask you to buy the water guard?
R_{50}: I tried to get it but I was unable
I: It has been 3 months now I don't think you are going to buy it again.
R_{50}: I promise I will buy it
I: It is not about you promising but you knowing the benefits
R_{50}: I will buy it when I start to go to market. Now that the tap water is not running, buying water guard will reduce the buying of pure water!
I: Like how many pure water do you buy daily?
R_{50}: Like a bag for 2 days.
I: If you buy a bag for two days regularly, you will be spending up to N200 naira in a week.
R_{50}: I would have bought it had it been that I pass through Omida
I: But there is one at Adatan
R_{50}: I only know the one at Omida. But it would have been easier if you have been bringing it here along with you
I: *(They are asking me to be bringing it, it would have been a good business but it will introduce bias into my work) – remarks to Jenny*
I: When was the well constructed?
R_{50}: About 30 years

Sample number: ITK 1, Group 4
Well location: Ologunebi's Compound, Ifote-Itoku, Abeokuta
Interview dates: 24/05/07; 26/06/07; 18/07/07

Respondents' profile:

R51
Sex: Male
Age: 40 years
Occupation: Traditional medics
Formal Education level: Secondary
Well ownership status: Resident user

R52
Sex: Female
Age: Not obtained
Occupation: Not obtained
Formal Education level: Not obtained
Well ownership status: Resident user

Interviews:

I: If you have started using water guard, I will take some of the treated water, test it and bring the result.
R_{51}: Thank you so much
I: I want to take little out of the well water again, is the well opened?
R_{51}: Yes
I: The previous result showed the presence of E. coli; it can course cholera and diarrheal
R_{51}: We don't drink from it; it is only used for washing of plates and bathing
I: As long as it is being used for washing dishes and bathing we cannot be so sure that it will not get into our mouth particularly the children. So what do you think you can do to improve the quality of the water because you own and use it?
R_{51}: We came here to rent a house and if there is any suggestion you have about that we shall explain to others when they come
I: We mention some of the courses last time like the state of the well surrounding and the issue of using different buckets to draw water. And if you can fix ring inside it and have one above the ground level.
R_{51}: Is it like borehole?
I: No, borehole is smaller than the ring.
R_{51}: It is there, the well has two or there rings (the well actually has ring lining, which is sub-merged under the water level and it is a low-lying well)
I: Okay but it is not raised above ground level
R_{51}: It is individual capacity (referring to what the landlord can afford)
I: If we do that it will be able to stop flood from entering the well during the raining season.
R_{51}: The environment you are talking about, it is only God that can help us. We have talked so much but our people are not yielding. I however feel that if the government comes in now and arrest some people all this throwing and dumping of refuse will stop. We are not police or sanitary inspector; there is nothing we can do. We have been arrested before and if they (the police) come again we shall take them (the police) to every of their (refuse dumpers) door steps.
I: So you are saying that there is nothing you can do except if the law enforcement agents intervene.
R_{51}: No
I: I brought this to show you. It is used for killing water germs; one cap full is enough for 25l of water. I will advise that you use it for the water before you use the water for anything. The instruction on how to use it is there on it
R_{51}: Are you selling this or you want to give us?
I: I brought this as a sample to show you
R_{51}: How much is it?
I: I bought it for N80.00?
R_{51}: If we apply this can we drink the water?
I: Yes you can drink it and use it for other things

I: Aunty what do you use the well water for?
R_{52}: Bathing

I: It is better that you too use this thing (water guard) because the water has been found to have virus in it which can cause sickness.
I: Daddy what is your name sir?
R_{51}: Femi. Femi Bello; hope you are not taking us to anywhere
I: No sir, it is just that we take records of all the people that we speak to, just to know that it is not only men, women, old or young alone that gave us information
R_{51}: Okay
I: How old are you sir?
R_{51}: 40 years
I: Which work are you doing?
R_{51}: I am a native doctor
I: What is your education level?
R_{51}: Secondary school
I: I will come again in a month's time to see if there are any changes and if you have started using this chemical, I will want to take sample of the water that you have treated so that we can see the influence of using the chemical, if any
R_{51}: Are you coming back in a month's time?
I: Yes
R_{51}: I will prepare the water for you before you come
I: It will also be better if you can do something about this environment
R_{51}: On the environment I've told you that there is nothing we can do, but when you come again, if you want to talk to those who are using this place I can take you to their houses and whatsoever you want to say you can say it to them directly.

Sample number: ITK 3, Group 4
Well location: 16, Jojolola Court, Kemta- Idaro, Itoku, Abeokuta
Interview dates: 24/05/07; 26/06/07; 18/07/07

Respondents' profile:

R53
Sex: Female
Age: 40 years
Occupation: Tie & dye fabric maker
Formal Education level: Secondary
Well ownership status: Resident user

R54
Sex: Female
Age: 72 years
Occupation: Tie & dye fabric maker
Formal Education level: Secondary
Well ownership status: Source owner

Interviews:

I: What do you use the well water for?
R_{53}: We do not drink the well water.
I: Are you using it for dish washing?
R_{53}: Yes
I: If you are using it for washing and bathing how are you sure the water do not get to your mouth?
R_{53}: We don't even know, we have put cover several times and we have decided to leave it since we are not drinking it
I: It is true that you are not drinking it but yet you are still using it for things that have to do with the body and also the children are also there. Water care is very important
R_{53}: What can we do now? It is better for us to lock it up. It is God who has been keeping us.
I: Is there an alternative water source if you lock it up?
R_{53}: We would find it or people uses it to clean up after toilet isn't that dangerous and contagious

R_{54}: Has it been treated?
R_{53}: No, she came before and promised to come back if there is problem
R_{54}: Is it this one alone or there are others too?
I: There are other wells
R_{53}: What about this one?
I: It is bad, but there are things you can do
R_{54}: We would do it if it is in our capacity
I: This environment is dirty, the toilet should have been 10m away from here, to this the only thing we can do is to fix ring into it and put a cover on it, we can then attach a bucket to the cover to prevent people from bringing different buckets to draw water out of the well. I also have this chemical with me, it is called water guard. One capful is meant for 25l of water. If you apply it and leave it for 30minutes, you can use the water for anything.
R_{54}: There is nobody to call upon for assistance, we are not living here before, we work here, and our children come here after school. If we want to put ring that is not going to be small money. What I will want to suggest is that may be we can use cement to plaster the inside and leave the base and then look for something to treat the little water we get from it (the well).
I: The most important thing is to do something that will correct the defects, why ring is better is because it is durable, the idea of cement may have to be a yearly repetition
R_{53}: If my husband heard about it he may ask us not to use the water for anything again
I: I hope you take the steps. I will collect the water now and come back again after four weeks to see if the quality is affected by rain. I will bring the result of the sample with me and also if you have started using the chemical, I will collect the treated water and test it so that we can see if there is any difference.
R_{54}: Since we have heard now we will try our best because the well is useful for us all
I: It will be better also if this gutter (drains) can be completed with cement to prevent standing water around the well area.
R_{53}: The issue of gutter making is more than what one person can handle here. The man who donated that toilet for our use promised to do the gutter but as things are now that is not certain again. But I will tell the others and try to contribute money even to make the gutter.

I: You can tell your neighbours all that I have said and try to get the water guard
R_{53}: How much is it?
I: It is eighty naira and it is available at Precious Pharmacy outlets.
R_{53}: I will buy it
I: What is your name?
R_{53}: Mrs. Makinde
I: How old are you?
R_{53}: 40years
I: What do you do for a living?
R_{53}: Designer (Tie & dye fabrics designer)
I: Education qualification
R_{53}: Secondary School

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R_{53}: Mama is not around; she is the one who did this for us.
I: Is it public toilet?
R_{53}: Yes, she even planned to do tap water but she was not allowed.
I: Is it commissioned?
R_{53}: No, it is not completed but now people are using it as a store.

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I: What do you do when you are sick?
R_{53}: Some people come here to sell us medicine
I: Is it native or orthodox?
R_{53}: Its modern drugs
I: When last were the drug sellers here?
R_{53}: Sometimes ago
I: Do you use herbs?
R_{53}: No, I don't because they don't wash the herb before cooking.
I: What about you children?
R_{53}: I treat them with drugs.
I: Do you just buy or are they doctor's prescriptions?
R_{53}: It is what the doctor gives us that I use for them.
I: How often is the sickness?
R_{53}: It is malaria
I: If it is not malaria how do you know?
R_{53}: At times it could be cough.
I: Do they have dysentery?
R_{53}: No; we don't pray for Cholera, we don't have it around here
I: When your children are teething, what do you use for them?
R_{53}: We use Bonababe (Brand name for a local teething medicine)
I: What about Mama does she use herbs?
R_{53}: She is not used to herbs; if she cooks herb and use it for two days she will throw it away
I: Is that why you are not used to herbs too?
R_{53}: I just don't like the use of herbs
I: What about your neighbours, do they go to hospital as well?
R_{53}: I don't know
I: How many of you use this well?
R_{53}: We are many
I: If you are counted, will you be up to fifty?
R_{53}: Yes, even people who come for party use the well.
I: Ok, thank you

Sample number: ITK 8, Group 4
Well location: 4, Kemta Odutolu Street, Itoku, Abeokuta
Interview dates: 24/05/07; 26/06/07; 18/07/07

Respondents' profile:

R55
Sex: Female
Age: 65 years
Occupation: Tie & dye fabric maker
Formal Education level: None
Well ownership status: Source owner's wife

R56
Sex: Female
Age: Not obtained
Occupation: Tie & dye fabric maker
Formal Education level: Not obtained
Well ownership status: Non-resident user

R57
Sex: Female
Age: Not obtained
Occupation: Not obtained
Formal education level: Not obtained
Well ownership status: Resident user

Interviews:

I: We found cholera causing germs in your water
R_{55}: What is the cause of that?
I: Exactly what I came to ask you…...What do you think you can do?
R_{55}: We don't drink the well water except use it for tie and dye. Originally it is not meant to be a well. We intended to construct a toilet before we discovered that it is a water logged area. We put two trucks of gravel into it to reduce the rate at which water was springing; otherwise this entire place would have been flooded.
I: But you also use it for dish washing?
R_{55}: Yes even for bathing and it causes nothing.
I: Mummy what I want to say is that health is wealth, the water we use to wash and bath there is no way such water will not enter into our body. I won't argue with mummy who said that they have not hospitalized anyone as a result of using well water but certain things may happen that you will not attribute to water.
R_{55}: Is there anything to put inside it
I: There is, but first we must take care of it and make its environment clean
R_{55}: We covered the well before but it was broken one night during the time when there was water scarcity people came at night to draw water.
I: I have this chemical with me. It is part of what government is using to treat tap water. I bought it at Precious Pharmacy it is called water guard. I will suggest that you apply it before using the water.
R_{55}: Can we drink such water?
I: Yes, you can drink it if you follow the instruction. Also if we take the other steps; like having a cover and prevent people from putting different bucket into it.
R_{55}: Are we going to pour water guard inside the well?
I: No, it is inside the water you fetch for use, one cap full will treat 25l of water. I will come back in four weeks time to see if there is any improvement and if you've started using the chemical, I will collect samples again and later bring you the result.
R_{55}: Where can we buy it?
I: Precious Pharmacy outlets at Omida, Adatan and Abiola Way.
R_{55}: Okay
I: What is your name Ma?
R_{55}: Mrs. Akinbule
I: How old are you?
R_{55}: 65yrs
I: This tie and dye is your work
R_{55}: Yes

I: Do you have any formal education?
R_{55}: No
I: Is this the Akinbule's compound?
R_{55}: Yes, we are in our father's house.
I: Thank you ma

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I: Good morning Mummy.
R_{55}: Good morning, how are you?
I: I am fine, did you buy that chemical?
R_{55}: Yes we did.
I: Can I have some of the treated water?
R_{55}: Do you say we should be treating the water? We thought that we are to put a drop into the water when we want to bath.
I: Yes, I said anytime that you want to use the water you should treat before use.
R_{55}: The well water when ever we want to use it we should put in a drop
I: Okay, have any one tasted the treated water to see the difference to tap water.
R_{55}: The water does not have taste, we use it for cooking and after your instruction we have been treating the water.
I: Do they follow the instruction on how to use it?
R_{55}: That will be when you come back again because we are illiterate.
I: Aunty, can you read the instruction and explain it to Mama.
R_{55}: They are visitors here.
I: Do you see that jerry can; one capful is alright for 25 lit. Do you understand what I'm saying?
R_{55}: We do wash the well it is some tout who broke the cover.
I: What do you do when you feel sick, how do you treat yourself?
R_{55}: I buy drug and sometimes go to hospital
I: When last did you go to hospital?
R_{55}: I am just getting out of one.
I: How many months or weeks ago?
R_{55}: About 3 weeks
I: What did the doctor say the problem was?
R_{55}: Just fever and I use herbs
I: Who prescribed the herbs for you?
R_{55}: I have people at Itoku herb market who selected the herbs for me
I: Are you the one that told them what is wrong with you then they prescribed for you different sorts or what?
R_{55}: Fever herb is an ancient one it has no variance we know what to use.
I: Was it fever that you have?
R_{55}: Chicken pox is another common sickness to some people.
I: What about dysentery?
R_{55}: No we don't have such sickness.
I: What about the children, do they have dysentery?
R_{55}: No; if children are properly taken care of especially if they are given native incision during teething….
I: Sorry to cut in, is there teething incisions?
R_{55}: Yes and if they have temperature it will surely stop.
I: Please Mama do try and use that chemical (water guard).
R_{55}: We would use it, it is for our benefit.
I: Mummy, is that your toilet?
R_{55}: No; it is for the hens.
I: Where is your toilet?
R_{55}: Our toilet in this neighbourhood is 'short put'… (Bush site sanitation)
We try about three times.
I: How many people are using your well?
R_{55}: I can't say; when there is no tap many people come here for water.
I: Thank you ma

I: Aunty how do you treat your children when they are sick? How do you take care of them?

R_{56}: I do not live here
I: Oh ok, but normally what do you do?
R_{56}: We give them drugs
I: How do you know the kind of drugs to use?
R_{56}: It depends on the type of sickness they have
I: How do you know the type of sickness?
R_{56}: We take them to hospital if it not what we can handle so that we get prescriptions
I: Do you use herbs?
R_{56}: Yes, we do
I: Who prescribes the herbs for you?
R_{56}: We have customer (a herb seller who they frequently patronized) and take the children there
I: Do you tell the herb seller what you want or he just prescribes for you?
R_{56}: We take the children to him so he knows what to do
I: When did you visit last with your child?
R_{56}: It's been a while
I: How young is your child?
R_{56}: He is quite young
I: Do you have regular supply of water?
R_{56}: Yes, very well
I: In the absence of tap water what water do you drink?
R_{56}: It is regular. Even when it goes off, it does not take more than two days before the tap runs again
I: What about the dry season?
R_{56}: It is regular

I: I thought you did not want to come out
R_{57}: No, I was busy inside
I: Ok, what is wrong with your child?
R_{57}: My child? There is nothing wrong with him
I: We were told that he's sick
R_{57}: Yes
I: So what did you do?
R_{57}: We took him to the hospital
I: What did they prescribe for him?
R_{57}: They gave him different types of drugs?
I: Can you tell us one of them?
R_{57}: I really do not know their names
I: How did you acquire the drugs then?
R_{57}: They gave us the drugs in prescription sachets, the names were not written on the sachets
I: oh, ok

Sample number: ADG 5, Group 5
Well location: 1, Ayo-Oluwa Close, Saraki-Adigbe, Abeokuta
Interview dates: 23/05/07; 20/06/07; 18/07/07

Respondents' profile:

R58
Sex: Female
Age: 50 years
Occupation: Trader
Formal Education level: Not obtained
Well ownership status: Source owner's sister

R59
Sex: Female
Age: 30 years
Occupation: Trader
Formal Education level: Secondary
Well ownership status: Resident user

R60
Sex: Female
Age: 25 years
Occupation: Trader
Formal education level: Secondary
Well ownership status: Resident user

R61
Sex: Male
Age: 27 years
Occupation: Student
Formal education level: Higher
Well ownership status: Resident user

Interviews:

I: Do you drink the well water?
R_{58}: Yes, there is nothing wrong with the water
I: When it rains, and the water level rises, will you still drink the water?
R_{58}: That's how it's going to be; when it rains we drink it.
I: How old is the well?
R_{58}: About 20 years
I: What is the name of this area?
R_{58}: Saraki Ilupeju.
I: There was rainfall yesterday
R_{58}: Yes, but it was not much
I: Do you allow non-residents to draw water here?
R_{58}: Yes, but we don't allow them to use or fetch with bucket except our own.
I: Where do you keep the bucket that you use?
R_{58}: Inside the house.
I: What type of toilet are you using?
R_{58}: It's over there; it is the water system.
I: The bucket you are using to draw out water from the well, why don't you tie it to the cover?
R_{58}: Should we put it inside the well; we keep it inside the house.
I: If you permit me, I want to carry out some test on the water to see how good it is
R_{58}: How are you doing it?
I: Yes, the result looks good
R_{58}: So we should tie the bucket to the cover and keep it inside the well?
I: Yes, that will be nice. I will take another sample from the well to test for the presence of virus or germs
R_{58}: Thank you. The well water looks like this because the water level is almost down to the ground (i.e. very low) if it was in the morning you wouldn't believe it is the same well.
I: What is your Address?
R_{58}: 1, Ayo-Oluwa Close, Saraki, Adigbe

I: We are looking into well water safety. Do you drink well water?
R_{59}: No.
I: Why?
R_{59}: We fetch water from the tap; some may be drinking it because so many people come here to draw from our well.
I: So, you do not drink well water because you have tap water?

R_{59}: In Adigbe here people do not really drink well water. We do believe that it is not hygienic to draw water from the ground and drink such. In dry season like this, many wells are without water but this well does not dry up.

I. We are going to check it now and I will show you the result but the one that we will not be able to do here is the check for disease-causing germs. As I have explained to mummy if it has germs you will see me again and the reason is that you are the one using it and we should be able to talk on how to improve it. Is that the soak away over there? I want to measure the distance to the well.

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I: I was thinking that since the rains are here there may be reduction in the contamination level but what we discovered does not mean that the area is the problem. I will come back again in another four weeks time and I will come with one of my supervisors

R_{58}: Can you give us the date of when you will be coming?

I: I will be around 3rd week next month

R_{58}: I will buy the chemical so that you can get some sample when you come

I: I met some people who said they are not drinking well water but they bath with it they put a child of eight months in a water basin and coming back the child has been drinking the water. So I told them that we deceive ourselves when we say we don't drink the water.

R_{58}: It is true

I: That's why we have to do everything possible to make it safe. So, no one bought it in the house?

R_{58}: We didn't buy it.

I: I thought the rain will have effects on it because the last time we came it was during the dry season but it didn't. The water level cannot be more than three feet

R_{58}: The water even went down –is it at the same stage/level?

I: Yes, so you need to use what I have introduced to you

R_{58}: What about if we are using it for bathing only & not drinking it

I: It is the same thing; you have to use it to make water safe for everything.

R_{59}: We would have to turn to the use of pure water for drinking and bathing. Please can you explain what is there to us?

I: We found E. coli is the water sample. I came in dry season to take sample and again last month to see whether rain will have any effect on the water, but the rain is not having any effect on it so I think it is more on the state of the well, I now recommended that you treat the water before using it for anything. The water guard is a chemical for house hold water treatment.

R_{59}: How much is it?

I: It is eighty naira

R_{59}: Where can we get it?

I: At any precious pharmacy outlet

R_{59}: You these people are wicked since last month you failed to tell me

R_{58}: Sorry it's only that my mind is not there

R_{59}: The only thing I heard is about this cover and we told the landlord about it.

I: If you can take proper care of this well and use the water guard there is no need running after tap water.

R_{59}: I will be taken my water guard every where with me.

I: Why is your mind not there? Try to encourage everybody

R_{59}: If I want to cook I will use it.

I: Water guard makes water good for consumption.

R_{59}: Is it worse than before? *(Respondent reacting to the nitrates testing)*

I: No, but the contamination level remain unchanged. It is now left to you to take good care of the well.

R_{59}: Is rain water not good?

I: It is good but that depend on where you are collecting it from and what you are collecting it with. Rain water ought to be the best but the sky is polluted.

R_{59}: We are drinking the well water

I: That's why I said anything I discover there I will report back to you but I have only one round of visit left now.

R_{59}: It would have been better if we can pour it inside the well
I: The problem is there is an amount of chemical you can put to a certain volume of water and knowing the volume of water in a well is difficult. I will come back again next month. So can I get sample from those that have it at home?
R_{58}: Do you have it?
R_{59}: I don't know they ask us to buy anything
I: You have heard about it now I will show you a sample of it. What is your name?
R_{59}: Mummy Salem
I: What do you do for a living?
R_{59}: Trader
I: What about your education?
R_{59}: I stopped at secondary School
I: How old are you?
R_{59}: 25 years
I: Are you sure?
R_{59}: What is the name?
I: Water guard

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I: I explain why it is important to mummy the other time. This is my third time of coming. I told her that you should not allow more than one bucket to enter into the well and why I kept coming frequently is that we discover it has disease causing germs and the prevention to it is to use this chemical, and you even have a baby……..
R_{60}: We only cook and wash with the water
I: The water we are using for cooking is already in our month, it is ₦80.00
R_{60}: Write the name and give it to mummy
I: We are mothers I think that we should be concerned about health matters and do not wait until something bad happens.
R_{60}: God will keep preserving us from evil
I: Water guard is not expensive. It contains chlorine which kills water germs
R_{60}: Is it harmful to touch?
I: Yes. I will leave a space of 3 to 4 weeks before I come back again and I will bring the result of both the well water & the treated water
R_{60}: I want to ask whether we can buy the chemical and pour it directly into the well.
I: No it has a measurement that you can apply to a certain volume of water.
R_{60}: I want to ask whether it is right to use it on water for washing or cooking as well
I: You can use it for anything. Do you use tap water for washing and cooking?
R_{60}: Yes
I: This chemical is part of what they use to treat tap water.
R_{60}: If it is applied to well water will it will be drinkable?
I: Yes, you can use it for anything.
R_{60}: We would not need to boil it again?
I: No
R_{60}: Where can we get it?
I: Precious pharmacy
R_{60}: Do you need marketers?
I: I don't need a marketer.
R_{60}: It is okay
I: I bought this as a sample
R_{60}: Can you give us out of this one?
I: No I can't
R_{60}: Have you opened this?
I: Yes, I use it for the water samples that we are taken.
R_{60}: May God help us. Please write the name for us because I am forgetful.
I: ok
R_{60}: Is it good for nursing mothers? I use tap water but when there is no tap I use it for cooking and washing.

I: Yes. I will come next month and if you've started using it I will take samples for testing and bring the result.
R_{60}: We shall be expecting you

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I: Has people come to fetch this morning. Do you remember to buy what I asked you to buy?
R_{58}: No
I: What about other people in the house
R_{58}: They are coming
I: I can see that you attached a bucket to it.
R_{58}: We can not do much now till the dry season
I: So you are starting work when dry season comes?
R_{58}: Yes
I: Well you said so; what about the water guard do you remember to buy it?
R_{58}: No
I: The state of the well is as we left it; nothing has been done other than waiting for dry season to come, and as for the household treatment am not sure anything is done either. The last sample we took we thought the rain will have effect on it but it did not.
R_{58}: Please listen to what she is saying; you are all hearing it now.
R_{61}: Where do you come from?
I: UNAAB
R_{61}: Which department?
I: Department of water management
R_{61}: Is government giving us water?
I: They gave tap water but we are here because of the well water
R_{61}: Please what is your name?
I: Mrs. Oluwasanya
R_{61}: I am happy that you meet me am happy that you bring the result of what is being put into the well. What about if we are boiling the water to kill the germs?
I: Chemicals also kills germs
R_{61}: Is that so?
R_{58}: When are you coming back?
I: Around 3rd week in July and I may come with my supervisor
R_{61}: Where can we get the chemical?
I: At all precious pharmacy stores; one is at Omida, Abiola way and Adatan
R_{61}: How much is it?
I: It is eighty naira only
R_{58}: What about rain water; is it good?
I: It depends on how you collect it. Rain water is the best if it is properly collected and covered after collection. Do you know if other people in the house bought it?
R_{58}: I cannot say, I told you the last time that if you are selling it I am ready to buy it
I: Selling is not part of my work. I bought one to show to people so that they will be able to identify it when they see it in shops. I thought rain is going to have effect on the well water but it still has the same nitrates level; nothing has changed.
R_{58}: You can test it today again
I: I will take sample again since there has been more rain fall
R_{58}: Since you said we cannot put the chemical inside the well and we are only using it for cooking we didn't bother again because the tap is running now
I: But last time when there was no tap water people were fetching this water
R_{58}: May be those are outsiders (non-resident), we always have enough tap water in our drums for cooking and drinking. It is only occasionally when we want to do something (party) that we use it for cooking or drinking.
I: If you have been using it now I may have ask you what difference you notice between the treated water and tap water. I bought it for N80.00
R_{59}: I saw the chemical at Isale Kuto
I: What are they selling there?
R_{59}: It was in a shop

I: Do you notice any difference when you used it?
R_{59}: Yes
I: Like what
R_{59}: I can't really say
I: You don't remember the difference
R_{59}: We do not drink the water; we used it for washing and cooking
I: When you use it, leave it for thirty minutes before drinking. Then compare it with tap water. I will like you to find out what you think
R_{61}: Will it be good for cooking after use?
I: Yes
R_{59}: If there is no tap water can we drink this?
I: That is what it's meant for; if we take proper care of our well and use this chemical on the water there may not be the need to run after tap water

I: There are some things that they promised to do about the well area.
It was the owner's initiative. Apart from enforcement what other thing do you think could work?
R_{61}: Well may be like locking up the well.
I: Do you think Mama will accept that if you suggest it?
R_{61}: Yes
I: What other things do you think can be done?
R_{61}: Try to educate them on how the well could be monitored, may be in one of our tenant meetings.
I: Do you think you can do that, I mean educate them?
R_{61}: I can do that
I: Will you?
R_{61}: I will do that, I'll do my best.
I: People said they don't get sick, is that correct?
R_{61}: I've said it that people get sick
I: What type of sickness?
R_{61}: I can't say
I: But you are aware that they get sick.
R_{61}: Hen (yes), I go out in the morning and come back in the night. On Sundays I go to Church.
I: Apart from getting water guard for yourself, do encourage others and talk about other problems in your next meeting. What is your name?
R_{61}: Kayode Okeowo
I: What do you do?
R_{61}: Student HND II
I: How old are you?
R_{61}: About 27 years.

Sample number: ADG 7, Group 5
Well location: 2, Ogunbodede close, Saraki-Adigbe, Abeokuta
Interview dates: 23/05/07; 20/06/07; 18/07/07

Respondents' profile:

R62
Sex: Female
Age: > 50 years
Occupation: Trader
Formal education level: None
Well ownership status: Source owner

R63
Sex: Female
Age: 30 years
Occupation: Trader
Formal Education level: Secondary
Well ownership status: Resident user

R64
Sex: Male
Age: Not obtained
Occupation: Islamic Teacher
Formal Education level: Secondary
Well ownership status: Source owner

Interviews:
(R62 gave answers relating to her well, but took a written note to pass to her neighbour)

I: Why do you not drink the well water?
R_{62}: It doesn't taste well like tap water
I: What exactly do you use the well water for?
R_{62}: We use it for cooking, bathing
I: Do you have one doro for the well or you allow individuals to come with their fetching buckets?
R_{62}: People bring their own doro; fetching bucket
I: What type of toilet do you have here?
R_{62}: Pit latrine
I: I will like to see it, how far is it to this well?
R_{62}: Should they take you there then?
I: Yes, I want to see it

I: How many rings are in the well?
R_{62}: $7^{1/2}$ rings; we want to dig it deeper but we are hindered by stones.
I: Do you lock the well always?
R_{62}: You met it locked. It is the well I am using. I am drinking it; I have to take care of it.
I: So you know that well water needs to be taken care of.
R_{62}: It needs care, even when we lock it some people may want to force it open.
I: I want to see how good the water is for consumption. If the water is not very good, the colour of this paper strip will change.
R_{62}: You mean it will change?
I: I will show you…..It looks good; the meter reading is six mg/l. The standard is that it should not exceed ten.
R_{62}: Thank you.
I: I suggest however that you use only one bucket to fetch from the well. Tie a bucket to the cover and lock it inside the well.
R_{62}: That is what I have been doing but people when they come for water sometimes go away with the doro
I: I will have to take this sample with me to check whether the water contains disease-causing germs. Although it should not have with the result of the nitrates test that I just did but one cannot be so sure.
R_{62}: Okay, it is true
I: If it has germs, you will see me again and we shall discuss further because whatever that will affect our health must be taken care of.
R_{62}: It is true

I: The difference between this well and the other one there is very high. The reading, which I said should not be above 10 mg/l, is 152 mg/l and yours is just 6 mg/l.

R_{62}: Hem.

I. I suspect the absence of lining and proximity of this burial site as the cause of the huge difference and of course, mama said she supervises those who operate her well!

R_{62}: Is that the reason? In that case the pollution we are causing is much.

I: We should take care of the water we drink. We made it by ourselves and we should be responsible for its care

R_{62}: I appreciate you very well. I listen to you because you are not a government agent. I will not listen if you are from government because the government has done us no good.

I: I've checked everything including the distance of your toilet to the well.

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R_{62}: People have come to fetch it this morning.

I: Did you tie the doro (bucket/rope) to the cover?

R_{62}: Yes but the rope cut this morning.

I: The water level has really risen?

R_{62}: Yes

I: Mama when did you install the ring lining? How many years ago?

R_{62}: It is a long time

I: Have you re-dug the well?

R_{62}: No

I: When was the well constructed?

R_{62}: About 3 years. I don't allow people to talk or use chewing stick beside the well or talk beside it. It's me that knows how much I am spending and have spent on the well. I will give you a paper to write your observations. I will deliver your message when the landlord comes.

I: My advice is that a drawer should be dedicated to the well, and make a good cover. As it is now, it is exposed to all manner of dirt; the lizard and even hen can defecate in it. Fourthly, the pavement should be extended round the well and it should have drainage. After fetching the water you can treat it with this chemical. It is known as Water Guard, it cost only ₦ 80.00 at Precious Pharmacy in Omida. One cap is enough to treat 25liters of water, apply it and leave the water for 30min after which you can use it for any thing. The chemical will take care of all the germs and virus, which we don't have control over.

I will come back in another 4 weeks time to see which of the steps you have taken and to take sample of your treated water if you've started to use the chemical. And about the non-resident users, I think it is the example you laid that they will follow.

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I: Do people disturb you about the bucket that you tied to the cover or break it?

R_{62}: No, they queue for water

I: They don't argue with you

R_{62}: No, they don't.

I: Is it the water guard alone that you are yet to buy?

R_{62}: Yes, we shall get it before you come again

I: I hope you buy it. Thank you Ma

I: Good morning.

R_{63}: Yes good morning

I: Is Alfa around?

R_{63}: The Landlord is here, he is the Alfa the other boy is a Quran student.

I: Okay. We came back to give you the result; last time you are not around. Did you get our message?

R_{64}: Yes, they told me about the ring, cover and everything

I: I left something for you to buy and use before using the water, are you aware?

R_{64}: No

I: I wrote the name and gave it to Mama she promised she will give it to you. Because we think that the grave is too close to the well.

R_{64}: I understand that
I: Another thing that I want to know is that if all these measures are taken will you be able to control everybody in the house to follow it?
R_{64}: Yes, they can be controlled. Are we putting this (the water guard) in the well?
I: No, you will put it in the water that you fetch.
R_{64}: Okay.
I: Over there they said the Landlord is not resident and it will be difficult to control the water, we asked for what their reaction will be to government task force intervention in well supervision?
R_{64}: Yes we would accept to it when we finish the well maintenance works
I: How long will that take you?
R_{64}: Our problem now is the rain, we have to wait for the rain to stop, if not so we would have started the work
I: What do you do when you get sick?
R_{64}: We are healthy here
I: What about your children?
R_{64}: They don't sick except when teething, all is right when we use Paracetamol (pain killer)
I: How do you know it is paracetamol you are to use?
R_{64}: That is what we have been using from the on set.
I: Is paracetamol the cure to all illness?
R_{64}: No, at times we use herb.
I: Who prepares the herbs for you?
R_{64}: We go to the market for it.
I: How do you identify the herbs?
R_{64}: I know them; I lived in the village.
I: So you tell them (the herb sellers) what you want?
R_{64}: Yes and they also include others.
I: What is your name?
R_{64}: Abdulasisi Jimoh
I: What do you do for a living?
R_{64}: Quran Teacher
I: How many people lives here?
R_{64}: Around ten
I: Do you prevent outsider from using the well?
R_{64}: No
I: How do you control such people?
R_{64}: I will put a doro (bucket/rope) there and let them know that is what they have to use.
I: Can you give us an estimate of people that come to fetch the well from outside?
R_{64}: No, they are many
I: When did you dig the well?
R_{64}: Fifteen years ago.
I: What is the name of your area?
R_{64}: Ogunbodede Close, Adigbe
I: Since you are a teacher, do you teach adult as well as the children?
R_{64}: Both
I: Is it possible for you to introduce education about water and the care of the well?
R_{64}: It is possible

Sample number: KMT 1, Group 5
Well location: Block 11, Area A, Kemta Housing Estate, Abeokuta
Interview dates: 22/05/07; 19/06/07; 19/07/07

Respondents' profile:

R65
Sex: Male
Age: 44 years
Occupation: Lecturer
Formal education level: Higher
Well ownership status: Resident user

R66
Sex: Male
Age: 40 years
Occupation: Technician
Formal Education level: Higher
Well ownership status: Resident user

R67
Sex: Male
Age: 12 years
Occupation: Student
Formal Education level: Junior secondary
Well ownership status: Non-resident user

R68
Sex: Female
Age: Not obtained
Occupation: Trader
Formal education level: Primary
Well ownership status: Non-resident user

Interviews:

R_{65}: Sometimes back we tied a drawer to the cover but you know that after some time the rope became weak and cuts. When that happens it's only the bucket that goes down to the bottom of the well and it is difficult to remove so our people will not even make the effort. But if it is the drawer and the rope they will try to remove it.

R_{66}: It will be better to have a single drawer tied to the well because no one knows where others are bringing their drawer from; may be from the floor or toilet, but just tell us what you think we can do.

R_{65}: She has said it that we should fix rings inside the well.

R_{66}: I had once fetched water and frog jumped out of this well before. The bad odor is another thing even when you fetch it you will see some sediments in it.

I: Your experiences implied that individuals must treat the water that he is going to use by himself; government can only try.

R_{66}: I have even stopped using it for bathing because of the odour and itching that it causes.

I: You have talked about most of the solution; one extra ring will do a lot in protecting the well better. A permanent drawer to be used by all and kept inside the well will also be good. The addition that I will make is the use of household treatment after fetching the water for use. The chemical is ₦ 80.00; a capful will treat 25liters of water. Apply it, shake and leave the water for 30 minutes after which it will be safe for use on anything.

R_{66}: What causes the presence of nitrate in the water?

I: All that we have talked about are the major causes and nitrates is an indication that the water has problem which make us to subject it to further tests, which reveals that the water has E. coli. But water guard will take care of all that coupled with proper hygiene. Maintaining good hygiene is also important on treated water. I will come back in about 2 weeks because trying to monitor the influence of rainfall on the well and also to sample your treated water for laboratory test to see if there is any difference in the two. And to see which of the step we mentioned, you have taken and if not what are the limitations that you encountered. That is why I want to see everyone in the house.

R_{66}: We shall take the steps because the state of the water is bad especially when it has this germs, it looks as if someone spat in it.

I: The state of water is very important.

R_{65}: We caution those who come here to wash cloth not to stay close to the well.

I: The well is properly ringed. But contaminations in water have two sources either from beneath like from burial sites, toilets and soak away pit around.

R_{66}: What has burial site get to do with well water, do people dig grave near deep well?

I: Yes, such cases are common in town; wells that have several burial sites around it therefore if contaminations are not from beneath it must then be from the outside or above.

R_{66}: The things that enters from outside is around 75% for this well. People wash things around the well, people stand on the edge of well and all manner of things they put into it are the real causes of contamination and pollution. But do not worry Ma, you have informed us now. It is left for us to take action.
R_{65}: If you decide to take actions now what about other people?
I: That is the advantages they have over there, the well has about 25 rings. It also has a pump.
R_{65}: And they are the only one using it.
I: It has no problem yet they keep asking me to come and also asking either there is something in their well. And the men are also ready to spend money on it.
R_{66}: If they have been allowing people from outside to use it they would have spoiled it.
I: Who is going to snap us?
R_{65}: Come let us take photograph.
I: I will tell you when it will be Kemta's turn next time I am out. I will ask Pelumi to come and show you the water guard.
R_{66}: We would find solutions to it. It is important to buy the rings now; we shall clear its surroundings and block all the holes on the cover.
I: I am particularly concerned about the little children you may tell them this is drinking water yet they may go ahead and drink any available water.
R_{66}: Yes, even when they are in the bathroom, they cannot stop playing with water and sand.

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I: What is your name?
R_{67}: Akeem Tijani
I: What class are you?
R_{67}: J.S.1
I: How old are you?
R_{67}: 12 years old
I: Why are you not in school?
R_{67}: We have finished exams
I. What do you know about taking care of water?
R_{67}: You take care of water when you use water well
I: So how are we supposed to use water?
R_{67}: We use the good water to bath
I: Do you drink well water at home?
R_{67}: No
I: What type of water do you drink?
R_{67}: Borehole water.
I: How do you know it is borehole water?
R_{67}: They told me.
I: Have you drink well water before?
R_{67}: Yes
I: What is the difference between well water and borehole water?
R_{67}: There is no difference.
I: So you can drink this one.
R_{67}: Yes
I: And it does not have any effect on you.
R_{67}: Yes (meant no)
I: When were you sick last?
R_{67}: Long time
I: About how many months?
R_{67}: I can't remember.
I: What about this year.
R_{67}: Yes
I: How are you treated when you fell sick?
R_{67}: Mummy gave me drugs
I: Where did she get them from?
R_{67}: She bought them in the chemist.

I: Ok, did you also use herbs?
R_{67}: Yes, we do
I: What type of herbs?
R_{67}: Malaria herb mixture.
I: Have you ever had diarrheal?
R_{67}: No
I: What about your sister, has she?
R_{67}: No
I: Do you have your own drawer?
R_{67}: No
I: Is it good to put well cover on the ground like this?
R_{67}: It is not good
I: Why is it not good?
R_{67}: Because all the dirt's on the ground will come on it.
I: Why do you then put it on the ground?
R_{67}: There is no other place to put it.
I: What other thing is not good about this well?
R_{67}: Standing on the well edge.
I: Why is that one not good?
R_{67}: Because the dirt's from the foot will get into the well.
I: How many drawers should be used in a well?
R_{67}: Only one.
I: How should we be using the only one drawer?
R_{67}: It should not be put on the ground.
I: Are you putting this one on the ground?
R_{67}: We don't put it on the ground
I: What about when you are fetching water.
R_{67}: The drawer is most times in the water.

I: Good day Ma. I was told that you do not drink well water but borehole.
R_{68}: I do not live here.
I: I know. How do you know that it is borehole water that you drink?
R_{68}: Borehole and well, are they not the same thing?
I: So you regard borehole and well water to be the same? Do you take this well water?
R_{68}: Yes, we take well water
I: Does it affect you in anyway or taste differently?
R_{68}: Some taste differently but not this one.
I: So it doesn't affect you
R_{68}: It does nothing to us
I: Are you sure, with all this muddy ground? When was the last time you visited the hospital?
R_{68}: Me?
I: We asked your son what you do when he falls sick, what do you use?
R_{68}: Herbal medicines
I: How do you know the type of herbs to make?
R_{68}: As long as we can get the leaves
I: Do you know the leaves to get?
R_{68}: Yes
I: How do you know, did you train for it or what?
R_{68}: We were brought up with it
I: So what type of leaves do you get?
R_{68}: We get malaria fever herbs
I: What about typhoid fever?
R_{68}: No, that will not happen to us in Jesus name. We never had that before
I: Not to you and the children?
R_{68}: By the grace of God, no
I: What about diarrheal?
R_{68}: Not my child
I: So the only sickness that occurs is malaria fever?

R_{68}: Yes, when the body develops high temperature, we just use herbs and it will go
I: Foe how many days do you need to use the herbs before it goes?
R_{68}: If it is only the leaves, it takes 2 to 3 days but if we include ‘itakun’ (the stem), it takes about 5 days
I: What is ‘Itakun’?
R_{68}: That is the branch of the herb tree
I: Ok. What do you see in the well; I am referring to the cleanliness and operation?
R_{68}: You know that I do not live here, we just came to work. We will close the well, put the locks and return the drawer upstairs.
I: Is this how you always meet the well opened?
R_{68}: No, this is the cover. It is usually covered and locked
I: Oh so you are the one who opened it and placed the cover on the floor.
R_{68}: Yes
I: When you finish you will pick up the cover and place it back on the well
R_{68}: Yes
I: What about if the cover has picked up dirt’s because I’ve seen some hens moved around the cover.
R_{68}: There is no dirt on where we placed the cover
I: Are you sure of that?
R_{68}: There can not be dirt on it
I: What about your legs because I can see that you do not have any shoes on
R_{68}: I just took off my shoes
I: But you are standing on the well head
R_{68}: It will not affect it
I: Ok

Sample number: KMT 4, Group 5
Well location: Kemta Housing Estate, Abeokuta
Interview dates: 25/05/07; 26/06/07; 19/07/07

Respondents' profile:

R69
Sex: Female
Age: Not obtained
Occupation: School teacher
Formal education level: Higher
Well ownership status: Resident user

R70
Sex: Male
Age: 42 years
Occupation: Clergy
Formal Education level: Higher
Well ownership status: Source owner

Interviews:

The researcher had only few minutes with either of the respondents.

R69 is the wife of the source owner. The property, a storey building block is still under construction but the down part is completed and habitable.

R69 claimed that the well is used for both household and building construction works. When the building work is completed, a motorised surface pump will be installed to pump water into an already erected 1000 litres plastic overhead tank for in-house water distribution.

'Pure water' is being purchased in bulk for household drinking water consumption. The well water is presently being treated with Water guard for cooking and other uses. R69 is the second person in the course of the field work with prior knowledge of and usage of Water guard.

R69 however looked forward to drinking the well water once the construction work is over and a pump installed to the well.

Non-resident users are allowed to fetch if they can gain access to the well. Access to the well is possible during working hours when construction workers are at work. Afterwards, the gate to the property is closed to non-residents. R69 claimed that the well will not be accessible to non-residents once the building works are done.

Presently, all users make use of the dedicated bucket attached to the well. (The example created in this well location suggested the possibility of the usage of a dedicated bucket; an idea the researcher carried on and shared at many other subsequent well points).

KMT 4 is one of the 3 well points where the usage of dedicated bucket is practised prior to research visits.

The well is about 20 m deep and constructed in the year 2006. The well is completed with ring lining and a dedicated bucket for water bailing.

On the forth research visit to the well, a motorised surface pump had been installed and 4 pipe stands connected outside the property fence for non-resident users. On this visit as well, flooring of the ground area within the property and the well area had been completed. The well was no longer accessible as it has been sealed up after pump installation. R70 however turned on the water taps outside the fence to collect the water needed for sampling.

Sample number: OBK 3, Group 5
Well location: Wale Somorin Street, Obantoko, Abeokuta
Interview dates: 25/05/07; 27/06/07; 19/07/07

Respondents' profile:

R71
Sex: Female
Age: 55 years
Occupation: Trader
Formal education level: None
Well ownership status: Source owner

R72
Sex: Female
Age: 38 years
Occupation: Trader
Formal Education level: Secondary
Well ownership status: Resident user

R73
Sex: Female
Age: 26 years
Occupation: Student
Formal education level: Higher
Well ownership status: Resident user

R74
Sex: Male
Age: 24 years
Occupation: Student
Formal Education level: Higher
Well ownership status: Resident user

Interviews:

I: Good morning Mummy
R_{71}: Good morning
I: We found E. coli; one of the germs that can cause cholera in the water. Since you are the one using the well I want to ask what you think may cause this in your water.
R_{71}: This is the water we have been using. It is the water that I drink and use. And I have never been affected by cholera or anything
I: What about other users?
R_{71}: There is always a crowd of people on this well. In the morning and once the students are out from school. Many students usually come here to drink water to cool off from fatigue before heading home. The water is good and had been good water source
I: I can see that you have tied a bucket to the well
R_{71}: It has always been there. It is there when you came the last time.
I: There are rings inside the well
R_{71}: Yes
I: You will still need to make a cover to prevent dirt from entering into the well.
R_{71}: We made it before but the cover is always breaking. Had it been that it is ringed above the ground, that ring will have a small cover. We only raised this placed with block because of the children
I: Is it still possible if you called the bricklayers to fix the extra ring for you?
R_{71}: It is possible, but it requires money, but we will do it.
I: You will also need to monitor people who are using the well. If we have this kind of problem there is a treatment for such water. You can use this chemical, the instruction on how to use it is on it. One capful will treat 25 litres of water. Before you use the water you should buy it so that individuals can treat the water.
R_{71}: Where can we get it?
I: Precious pharmacy sells it.
R_{72}: What's the name?
I: Water guard. I will give you a month interval before I come back. Mummy what is your name?
R_{71}: Mrs. Ogunbode
I: How old are you?
R_{71}: 55 years
I: What is your educational qualification?
R_{71}: I did not go to school
I: Aunty what is your name?
R_{72}: Mrs. Talabi

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I: Do you stay here?
R_{73}: No, I am Lagos based but I school in UNAAB
I: Oh you school in UNAAB, are you all UNAAB students?
R_{73}: Yes. Is it the indigenes that you want to talk to or anybody?
I: No, anyone that lives in this house. So do you live here?
R_{73}: Yes.
I: What do you use this well water for?
R_{73}: I use it for washing, bathing and cooking, but I don't drink it
I: So you cook with it?
R_{73}: Yes
I: But you do not drink the water?
R_{73}: No, we don't
I: You cook with it and wash your plate with it and you are not drinking it, is it not the same?
R_{73}: It is not as if I am drinking it directly, you know, like drinking a whole cup
I: Why don't you drink it?
R_{73}: It has some taste in my mouth.
I: Apart from the taste, why else don't you drink well water?
R_{73}: I think it is not safe enough for drinking.
I: But you live here, why don't you do something about it?
R_{73}: It is the Landlady that can do something about it.
I: Have you ever mentioned it (the concern of well water safety) to the Landlady?
R_{73}: I do not think they drink the water as well
I: She told me that she does
R_{73}: ok
I: But if you find the water questionable why have you not mentioned it to her
R_{73}: Even if I mention it to her, she will tell me that she has been drinking it before I came into this house
I: Has she actually told you that before?
R_{73}: No
I: So it is an assumption. Is that the same for others too?
R_{74}: I don't really know
I: What water do you drink?
R_{73}: At times I go for pure water or tap water
I: Do you have tap water around here?
R_{73}: Yes
I: Where?
R_{73}: A borehole, there is a manual (hand-pump well) borehole down the road
I: oh, the hand-pump well, you mean you go that far and how do you bring the water home?
R_{73}: Sometimes I take bikes (motor bikes) or sometimes just look for small water kegs since I am the only one, and trek back home.
I: Do you have part of that water at home and can I have some of it for testing?
R_{73}: Yes
I: When did you collect it?
R_{73}: Yesterday
I: Okay, for how long have you stayed here?
R_{73}: I go home on weekends but not every weekend.
I: So you are not permanently here?
R_{73}: No, I go home at least once a month for the weekend
I: When you are sick what do you do, I mean how do you treat yourself?
R_{73}: I don't normally fall sick, except if I have malaria.
I: Except malaria? Is malaria not a form of sickness?
R_{73}: Not really, I have malaria when I have serious mosquito bites
I: I hear you, what about typhoid, have you ever had typhoid?
R_{73}: No
I: Are you sure?
R_{73}: May be, I have never done test for typhoid.
I: Ok, how do you treat yourself?

R_{73}: I buy drugs or sometimes go for injection.
I: Are the drugs and injections self medication or how do you come about them?
R_{73}: That is how it has been whenever I have malaria. I am an AA blood group person. Whenever I have serious mosquito bites and I feel the symptoms, I just conclude that it is malaria and I go for the drugs. If the drugs are not adequate, I go for injections
I: My question is how do you know what drugs to use; do you prescribe it for yourself or what?
R_{73}: There was this time that I went to hospital and the doctor prescribed for me. Since then I follow the same prescriptions like Attesunate (brand of anti-malaria drugs) and blood tonic
I: Even if it is malaria or not?
R_{73}: Yes
I: What is your name?
R_{74}: Joshua Oluwatobi.
I: Are you a student too?
R_{74}: Yes
I: You said you drink well water once a while and not always, why is that?
R_{74}: Only when I feel choked and I want to step down.
I: So you drink well water.
R_{74}: Yes
I: How do you feel about drinking well water, does it affect you in any way?
R_{74}: Some times
I: How?
R_{74}: Some times I have typhoid or fever.
I: How many times have you had typhoid?
R_{74}: I do not count
I: Okay, this year how many times have you had it?
R_{74}: Is it due to the water or just generally?
I: Generally
R_{74}: February 14 I was down with typhoid
I: You mean you were down with typhoid on the Valentines Day?
R_{74}: Yes, I was down with typhoid, I think they called it blood…
I: How did you come about it?
R_{74}: They called it blood ….something and it's close to or almost seven times now.
I: Seven times within what period?
R_{74}: You asked that this year
I: Seven times this year? (That will be seven times in 6 months)!
R_{74}: Yes
I: How do you know it is typhoid?
R_{74}: Or what do they call it? Did I say typhoid?
I: Yes, you said you had typhoid
R_{74}: Sorry, it is dysentery.
I: How did you feel then?
R_{74}: Just normal high rate of excretion that's all
I: High rate of excretion and how long does it last for?
R_{74}: It depends on how I use the drugs. Sometimes I do not use any drugs until it becomes critical. At that point, I go to the pharmacy and they give me drugs to use
I: So you have had that kind of excretion 7 times this year
R_{74}: Yes not exactly, but let's just say about 7 times this year
I: And what do you think is responsible for the excretion?
R_{74}: Probably change of water or food or something.
I: Change from where?
R_{74}: Change from, whenever I change my water or food that I am used to, like now I take cold soft drink
I: If you are not here as a student, where are you stay normally?
R_{74}: As in when on vacation?
I: Yes
R_{74}: I go home to Lagos
I: But you do drink this water any way?
R_{74}: Not often. Only when I am thirsty and I can not lay my hands on potable water…

I: What do you think can be done about this well?
R_{74}: People have been drinking it for long now. It is all about adaptability. When people get adapted to it and it has been doing them nothing, I don't see anything that can be done except may be the cover.
I: Do all the residents use this one drawer or you have separate drawers?
R_{74}: No, they do not allow individuals to use other buckets (do no have separate drawers)
I: Have you discussed with the owner about the changing of the cover?
R_{74}: Yes, she is at the verge of changing it
I: How do you know that?
R_{74}: We discussed it
I: When was this (your discussions)?
R_{74}: About two weeks ago
I: And by her response how soon do you think she is going to do it?
R_{74}: Right now we are having light problem (electricity power problems) and I think that's what's holding the repairs.
I: But how soon
R_{74}: I can't say that
I: What job does the owner do?
R_{74}: I can not go into that, I am not in the best position to answer that question
I: Ok, you do not know the details, is it?
R_{74}: I know but I do not know how she will feel if I discuss her personal details
I: I just want to know if she earns enough to sort out any problem with the well
R_{74}: She earns enough; she is the landlady for Christ sake! Aside her own stuffs, she can do it from the rents.
I: How many people live here?
R_{74}: This house is a local government council! (Kidding, but implying a lot of people)
I: How old are you?
R_{74}: 24 years
I: What about the other lady?
R_{74}: About 26 years
I: Ok, thank you

Sample number: OBK 9, Group 5
Well location: Olafimihan Street, Fajol, Obantoko, Abeokuta
Interview dates: 25/05/07; 27/06/07; 19/07/07

Respondents' profile:

R75
Sex: Female
Age: 31 years
Occupation: Hairdresser
Formal education level: Secondary
Well ownership status: Resident user

R76
Sex: Female
Age: 45 years
Occupation: Trader
Formal Education level: Primary
Well ownership status: Resident user

R77
Sex: Female
Age: 27 years
Occupation: School teacher
Formal education level: Higher
Well ownership status: Resident user

R78
Sex: Male
Age: Not obtained
Occupation: Technician
Formal Education level: Primary
Well ownership status: Resident user

Interviews:

R_{75}: Are you here because of the well, you better go and ask the landlord
I: I want to talk to both the owner and the users.
R_{75}: It is only the users that are around now
I: The water has disease causing germs and if we talk about improving the well through some rules and regulation - who will be responsible for implementation; the owner or users
R_{75}: Do you want to help us do something to the well?
I: We are going to check the water quality. If it is contaminated then we would try to identify the causes. Are there rings inside the well?
R_{75}: Yes. The problem with the well is that erosion enters it during the raining season.
I: How do you know that erosion enters the well?
R_{75}: After any heavy rainfall the water turns into a brownish colour.
I: Do you know whether the ring touches the base?
R_{75}: Yes, what people say is that the well water turns brown whenever it rains because our house is at the bottom of the slope but it is very white and clean during the dry season
I: Does it dry up during the dry season?
R_{75}: No, no matter how much you fetch it if you leave it for a while it will spring up in no time. If it is left for an hour you can have a drum full we don't lack water here at all
I: Why are people not drinking the water?
R_{75}: I don't know I am just talking for my co-tenant. During the time that I was not going to shop I used to fetch during the afternoon when it would have been left for a longer time, it is always very settled and clean. It is only such time that I used to fetch the water in those days.
I: That was when you are drinking the well water?
R_{75}: Yes
I: Are you drinking it now?
R_{75}: No
I: What about your children?
R_{75}: At times, not often
I: And it doesn't cause any sickness for them
R_{75}: No
I: They don't have cholera or dysentery
R_{75}: No
I: What are people doing to the well that makes you not to drink the water?
R_{75}: The reason is that this one is bringing his bucket you don't know where he picks it from, people use anything. It may even be because they do not drink the well water
I: How do you think you can stop this problem?

R_{75}: It is only if our landlord could take action against such things but he is a very quiet person. He will not talk even when he knows that it is wrong. So unless the landlord makes it a law that no one should put any other bucket into the well except the only one that must be used.
I: Do you have so many people living in the house?
R_{75}: No, but people come for water from outside. And our gate is always opened.
I: So, if you tie one bucket to the well and the gate is open people will still have access when you are not around, isn't it?
R_{75}: That is why I ask you to discuss with my landlord. He is a man that listens to advice and he could make a cover.
I: But you said the landlord comes home only on weekends, what about if you tenant contribute money to do it?
R_{75}: We can do it if others will corporate, and will not accuse others of anything, because if a person does it, it may be a problem on him/her. Like when my husband ask one of our co-tenants to close the gate one night, the person refused to answer my husband that night that it really turned to a big problem. I expected the landlord to come out and judge the case, he didn't come out at all instead he went to the other party who is wrong and started begging them.
I: Ok, what about if you make a cover and tie a bucket to it and always close your gate and there is a specific time to fetch water either in the morning or evening.
R_{75}: If that happens every body will drink the water
I: Ok, so we will be left with the problem of rainfall
R_{75}: Yes
I: Is it possible for the users to invest or spend some money on the well?
R_{75}: You may throw it to them first to know their response
I: Which one do you think is most important is it just having the water or the quality of the water?
R_{75}: What I think is that even if money is spent on this well people will still not drink the water; they will rather look for tap water. Although well water is good, the water at times has taste. I had already drunk one before I know it one day.
I: Do well water have taste?
R_{75}: Some well water is not drinkable.
I: Can you explain that to me?
R_{75}: Some well water is not that light in the mouth it will be so thick in mouth or heavy to taste.
I: If people for one reason or the other do not drink well water, it may mean that they have concern for well water quality and maybe doing something about the quality is hard for them. If you have a well and the water has problem and there is no alternative people will surely want to try to see what they can do to make it better. But since there are alternatives, people do not bother, they just look for alternatives or what do you think?
R_{75}: Our own well is good; it is among the best in this area
I: When will the landlord be at home?
R_{75}: On Friday
I: What about the wife?
R_{75}: She is usually at home in the morning and at night
I: I think it is better to speak with the man?
R_{75}: It is better but you can talk to the wife as well. Why are you recording our voice?
I: So that I can play back and write everything down later
R_{75}: Okay
I: How many rings do you have in the well?
R_{75}: Eight
I: The well looks old
R_{75}: Yes we too met it here

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I: I've been here before to see the water and I said that if I find anything bad in it I will come back to tell both the owner and the users. There are disease causing germs in the water which can cause diarrheal and cholera. Last time I came I ask them why the well has no cover since it was ringed
R_{76}: It has cover before but it was broken.

I: I suggest the use of water guard to treat the water
R_{76}: How can we determine the content that we can use to treat our storage tank or drums?
I: You can calculate it through the volume of the drum or tank. I will collect this water now for testing. I will also from the one which you have at home
R_{76}: Thank you ma
I: What is you name?
R_{76}: Mrs. Oyesile
I: What is your work?
R_{76}: Trading
I: Your educational level
R_{76}: Pry six
I: What is your name?
R_{75}. Mrs. Bola Erinoso
I: How old are you?
R_{75}: 31years old
I: Education qualification
R_{75}: Secondary school
I: I will be here by middle of next month so please try and use water guard before I come so that I will be able to get sample from you.
R_{75}: What I am saying is that if we tie one drawer to it, who will be responsible to replace it when it is damaged. And you know that if the work load on the drawer is much, it will get spoiled easily
I: Do you think it is not workable?
R_{76}. I don't think so, how can I allow anyone to use what I bought with my money anyhow.
I: I know it might not be easy buy I think we can talk to ourselves. Or even by the time you all sit down and talk to the landlord I think it can be workable.
R_{75}. I've been advertising for you
I: You are not advertising for me. I am neither the manufacturer nor retailer
R_{75}: I will buy my own when I go out today. Even the tap water we are drinking in this country its only God that is protecting us.
I: There is nothing that should prevent you from using well water if we take good care of it. Government also draws water from the river which is more exposed to dirt than well water. Well water is nearer than tap water if individual could monitor his well that would have been very good, but she says it may not work out.
R_{76}: If there is only one drawer because there is nobody who wants to provide such bucket.
R_{75}: How much is it; it cannot be more than ₦200.00
I. That's why I said everything depends on you, the resident users
R_{76}. We can be contributing the money for replacement or better rotate the replacement among ourselves.
R_{75}: What I know is that if we are determined we can enforce the usae of only one drawer bucket. I can even do it but the support of others is the major issue. Because in the past when such thing happened people prefer to stand separate. Everything depends on the landlord.
I: Is there no way that you can talk to the landlord?
R_{75}: When he comes tomorrow I will talk to him
I: Whatsoever he says I will like to know when I come
R_{77}: Please come and check our well too.
R_{75}: She is coming
R_{77}: Does she have plenty of the chemical with her?
R_{75}: No, just one for sample, you will get it tomorrow if you want to buy it
R_{77}: Where can we get it in town?
I: Precious pharmacy at Adatan
R_{77}: How much is it
R_{75}: It is ₦80.00
I: What is your name ma?
R_{77}: Bola Osun
I: What do you do for a living?
R_{77}: Trader
I: How old are you?
R_{77}: 27 years

I: What is your educational level?
R_{77}: Pry six
I: Thank you. Water guard is used for treating water. The instruction is on its side; a capful for 25 litres. Shake it and leave it for 30 minutes and after that the water is safe for use. I will take sample from the well again to see if rainfall has any influence on it. I will leave another one month before I come back again, if I come I will like to take sample of your treated water if you have started using the chemical and I will bring back the result.
R_{77}: So we are to go to precious to purchase it
I: Yes, I brought this along so that you will be able to identify it when you see it in the shops.

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I: Do you know when the well cover was given out for repairs?
R_{78}: Around last week
I: What else again has been done about maintenance of the well because Mummy Deji said she will talk to the Landlord?
R_{78}: No, I don't know but I am the one who helped them to give the cover to a welder for repairs.
I: Do you know if the repairs are finished?
R: I don't know, but it was only given to them last week and you know how the light (electricity power supply) is so erratic. No one can do any tangible work or repairs under that situation
I: Ok. There is this chemical that we ask users to buy to treat their water. Did Mummy Deji mention anything like that to you?
R_{78}: No, I did not know anything at all. I did not know that anyone was here to tell them anything
I: Okay, thank you. I will try and see Mummy Deji outside. Do you drink the well water?
R_{78}: No
I: What are you using the well water for?
R_{78}: Washing, bathing and cooking.
I: What water do you drink?
R_{78}: Tap Water.
I: Where is tap water here?
R_{78}: We fetch it from the other house
I: Why are you not drinking this (well) water?
R_{78}: Because there are too many people and all manner of things that people are putting in to draw out the water. This one will come and throw in his container, the other one will come and do the same, and this is not good. We have to wake up early to fetch water if we want to drink it at all….
I: So the residents fetch water in the morning if they want to drink the water?
R: Yes
I: Ok, what can you do if your reason for not drinking the water is because of what people are throwing into the well to fetch water? What can you do to control that?
R_{78}: There is nothing we can do except to repair the cover and we can not ask them not to fetch water because the landlord will allow them
I: What about if you use only one drawer?
R_{78}: That will be better, it will be good if the bucket will not be falling into the well, but you know the children, they will do it. They will loose the bucket into the well. When they fetch too much water, they will throw the bucket into the well and they will also try to get the bucket out by themselves when no one is at home
I: Ok, can we get some of the water you are drinking at home?
R_{78}: I have just parked my jerry cans to the shop. I have pure water that I am drinking at home.
I: What's your name?
R_{78}: Korede Olabisi
I: Which work are you doing?
R_{78}: Technician
I: What about your education
R_{78}: Primary Six
I: Do you think it will work if we ask government to monitor wells?
R_{78}: I can't say it will work or not
I: Why?

R_{78}: Because it is our well, if it has any problem, we are the ones who will fix it.
I: Do you think you and the Landlord can work with the government if they intend to use task force to monitor the well?
R_{78}: There is nothing we can not comply with because it will be for our good
I: Ok, when did you go to hospital last?
R_{78}: Thank God I have not been to the hospital
I: Do you mean that you have not been to the hospital all your life?
R_{78}: No, I mean that I have not been to the hospital this year
I: What happened to you when you went last?
R_{78}: I had malaria
I: How do you know it was malaria?
R_{78}: I went for test to know what was wrong with me
I: Who ask you to go for a test?
R_{78}: At the hospital
I: So it is the hospital that said that you have malaria and they gave you drugs for it.
R_{78}: Yes, when they check the result
I: And they confirmed that it was malaria
R_{78}: Yes
I: So they gave you drugs
R_{78}: No, I took injections
I: Do you use herbs?
R_{78}: Yes, I use malaria herbs too
I: Do you have stomach pain or dysentery?
R: What is that?
I: Like stomach aches, stooling and stuffs?
R_{78}: No
I: You never have such?
R: No
I: What about your wife and children?
R: No, such never happens to any of them
I: Alright, thank you. How many people live here?
R: Both upstairs and downstairs?
I: Yes
R_{78}: About 27 people
I: Ok, thank you.

Well location: OBK 10
Note: Interview session at OBK 10, the immediate neighbour of OBK 9. The well point is not included in the selected 25 observation wells

Respondent details:

R79
Sex: Female
Occupation: Trader
Educational level: Primary
Well ownership status: Resident user

Interviews:

I: Did your well dry up?
R_{79}: No, it is this well that we are drinking before
I: And it has no taste
R_{79}: Yes (meant no)
I: Did it dry up?
R_{79}: No. We observed that waste water from the soak away pit of that school, from their hostels is entering our well such that the water we fetch from the well is coloured and smells a lot
I: What did you do about the problem?
R_{79}: We complained to the people in the school, they promised to do something, but they did not. So we told the landlord about it and he made another well for us.
I: How long ago was this?
R_{79}: They just finished with the well. We are still waiting for the well water to fully settle.
I: Apart from the problem that this one is creating do you have any problem with this new well?
R_{79}: No, you can see the mud collected from the well. It's a new well
I: We observed that many who have well water do not bother about the care of it since they have alternatives but instead use it only for washing and things like that.
R_{79}: Tap water also is hard to get now people hawk it in some area like bread.
I: Is Commander (the landlord) living here?
R_{79}: No
I: When did he make the new well for you?
R_{79}: Last month
I: Do you have the problem of people coming with their different drawer (doro) to draw water?
R_{79}: They come with different drawers
I: And it doesn't cause any problem for you
R_{79}: It does not cause any harm for us.
I: But because the water is good you never think various drawers might cause problem.
R_{79}: Yes
I: Do you use alum to treat the water before use?
R_{79}: No
I: And you never had cholera or such before
R_{79}: Yes (meant no)
I: How many rings are in there?
R_{79}: 13 rings
I: Does the well dry up?
R_{79}: No
I: What we are also considering is that the government who are supposed to provide water for all is not forth coming.
R_{79}: And what about the government who disconnect pipe because of non-payment of monthly dues.
I: The government believes that they need money to maintain, treat and supply, you know that it is river water that government treats and supplies to the people. The question is will people take care of their well to an extent that the water will be like that of tap water. We don't know

weather the well owners will be able to do so. Like this I will test it and if there is anything there will our landlords be ready to take care of it and improve it to tap water level.

R_{79}: Fingers are not equal. People do not have the same financial strength.

I: Another thing that causes problem for well water is that it is exposed but this one has a cover and also there is ring to prevent contamination through the ground beneath and if there is no contamination from beneath it will remain on the surface. The drawers that people bring to draw water how clean are they, where are they brought out from, we would have to monitor that and my question is who is going to be responsible for all that. Is it the landlord or the users?

R_{79}: It is every one of us

I: Will that be possible?

R_{79}: Yes

I: Like attaching one drawer to the well?

R_{79}: That one cannot be possible; only myself and one other person has a drawer in this house

I: If you buy only one and tie it to the well and close the cover so that whoever that comes for water will open the cover use the drawer return it back into the well and close the well

R_{79}: It would have been better if everybody were at home today that you came.

I: When are they going to be at home?

R_{79}: Saturday

I: Morning or evening

R_{79}: Morning

I: I will try and come one Saturday then I will collect this water also to see how it is.

R_{79}: Which water, the well they have closed up?

I: I will still have to test it to know how bad the water is and come back to tell you.

R_{79}: Ok

Well location: IJM 6
Date: 19/06/2007
Note: Interview session at IJM 6. The well point is not included in the selected 25 observation wells

Respondent details:

R80
Sex: Female
Age: 75 years
Occupation: Retired Nurse
Educational level: Primary
Well ownership status: Source owner

Interviews:

I: Does erosion flow into it
R_{80}: Yes if there is heavy rain fall
I: I am going to draw little
R_{80}: This is the water that we are drink
I: The major issue is that govt. water (tap) is not evenly distributed that is why we are trying to see how good the well water is, which is the one people are using if they are good we would not bother. What is your name Ma?
R_{80}: Mrs. Shittu Coker
I: What is your educational qualification?
R_{80}: Primary Six. Is that all that you want to know?
I: Yes
R_{80}: We do not leave the well open; it is always closed
I: Ma, since you are using one doro why didn't you tie it to the cover and put it inside and also try to raise the well head to prevent flooding.
R_{80}: Okay
I: Are you a Nurse?
R_{80}: Yes
I: You will know about Nitrate
R_{80}: Yes
I: If the percentage of nitrate is high in water it indicates there is contamination in the water. World Health Organization recommends that nitrate in domestic water should not be above 10 mg/l but your water is 57 mg/l. If I should ask for reconstruction of the well, will you be willing to do that?
R_{80}: We used to pump it with engine (motorized pump) before
I: Look at this chemical it is chlorine it is formulated to treat drinking water. It is used to treat tap water too but before it passes through the pipe to us it can get contaminated again unlike well water that we have with us here. The instruction on how to use it is there. One capful for 25l of water, leave it for 30 minutes before use.
R_{80}: We would take care of it and clean it up.
I: If you apply the water guard the water should be drinkable
R_{80}: How much is it?
I: It is N80 at Precious Pharmacy
R_{80}: Can we apply it directly to the well?
I: No, draw the water out before use. You can use it for almost a month.
R_{80}: Write the name down for me "Water Guard"
I: I want to check the water level
R_{80}: We dug the well in 1972; my husband works with Water Corporation.
I: I will come in another one month time and by then I will want to take sample of your treated water.
R_{80}: Thank you.

Remarks: Mrs. Coker insisted on having the water quality of her well checked. The well point is not one of the observation wells. The owner supervises the handling of the well. Apart from household uses, she also sells the well water to non-residents.

A5. 3: Key Informants (KI) Interviews

KI 1

Sex:	Male
Age:	55 years
Occupation:	University Lecturer
Education:	Higher

Justification for selection:
KI 1 is the Chair of the Department of Water Resources Management and Agro-meteorology in the University of Agriculture, Abeokuta. He is a hydro-geologist, hydro-chemist and worked more than 20 years as a researcher in the field of hydrology and water management. He represents a seasoned hand in water management issues in Nigeria as a whole. And having lived and worked more than 20 years in Abeokuta city, the research study area, he has a wealth of knowledge about water related matters in the city. KI 1 owned a Water drilling Company that is responsible for many of the boreholes and water development projects in Abeokuta and environs. He is also a self supply owner.

Interviews:

I: What can you tell me about water supply availability in Abeokuta?

KI_1: Water supply in ABK had always been from the side of the government. It has always been the responsibility of government to supply water to the populace, but such action is limited to the urban areas. Teaming population leaving in the rural areas or outskirt of Abeokuta is excluded from the water supply and that restricted the impact of government of today to giving people of Abeokuta water. This makes them to fetch water for themselves through the construction of shallow wells where lithology of the area permits such construction. Where you have hard rock outcrops, people depend on rainwater for their water needs. Water could only be available to them during the rainy season, for the water is always dry generally for more than 6 months of the year.

I: What then happens in the dry season?

KI_1: In the peak of the dry season, people try to get surface water such as stream/river like Ogun River. Ogun River usually flows for 8-9 months of the year. Some streams are perennial most of the season.

I: In order words, you are saying that there is a link between the rock type and water supply availability

KI_1: Definitely, there is a link between type of rock and water supply. Rock type affects construction of shallow wells because due to the construction method that is used – mainly hand-dug method – they can only scrape such rock that are soft but Abeokuta is underlain by rock called granites, gneiss, etc These are hard rocks that do not make the digging of wells easy.

I: In your own view, what can you say about ground water quality in Abeokuta?

KI_1: Ground water quality naturally are suitable for domestic consumption, but there has been pollution due to mainly unhygienic practices of such water sources; mainly through already contaminated containers or dirty containers put into the water source.

Naturally one can say that ground water is ok for rural consumption, but pollution generally from dirty surroundings, waste dumps has made/rendered groundwater useless, but this is limited to certain depth of ground water.

I: How do you mean, 'certain depth of ground water'?

KI_1: Pollution is not general down the depth. Preliminary investigations into shallow hand-dug wells show that the upper portion of most wells in Abeokuta is contaminated. Depth of 10-15 m is no longer safe from contamination. One could say that most of the hand-dug wells within this depth range are already contaminated.

I: What are the possible causes of contamination?

KI$_1$: The causes are manifold. You could have:

- Domestic causes due to high (population) density
- Causes from cottage industry such as textile industry (not heavy, but micro-scale) industries all around the town
- Un-hygienic practices around hand-dug wells
- Causes due to solid waste that are dumped indiscriminately near residential areas

Causes coming from different types of sources: autochthonous source of pollution - impurities linked to the rocks or rock properties surrounding the wells or thru seepage – and allochthonous due to poor sanitation practices and un-hygienic practices of the people.

I: Sir, those are big words! I noticed household burial sites around the town; can you say they are possible sources of contamination as well?

KI$_1$: Yes. Burial of remains of human-body is a source of contamination. In fact, if you look into the history of Abeokuta or Yoruba race in general, loved ones are buried in rooms – the dead are buried in holes that are dug within the rooms without any form of lining. Nowadays however is much better because people are not allowed. But designated cemeteries that are reserved and recognized by the government are done without adequate cognisance of the geology of the area. You find cemetery at the bank of rivers such that during floods some organic materials are leached from the shallow burial ground from where it goes downstream and inhabitants exposed to pollution of the water source.

I: How then do you think this pollution can be abated?

KI$_1$: Abatement of pollution could be done particularly to the case of Abeokuta by increasing the supply of treated water from the State Water Corporation and thru provision of mini-water works and boreholes for those at the outskirt of the town. It is also important to let people know the danger they are exposed to when they use contaminated water. In doing so, government have to provide alternatives so that the people will not be forced to use contaminated sources.

I: In that case, there is no way the people can help themselves in solving the pollution problems of the water they are using

KI$_1$: Well, they could be advised to boil and allow the water to settle, but then, there are some impurities that can not be easily eliminated by boiling. I think the ultimate solution is for the government to ensure the provision of treated water; make it available to all and sundry. Well, I don't think it is a difficult thing to do.

I: I don't want to pre-empt your response here, but how long will it take the government to provide treated water for all and what can people do in the mean time?

KI$_1$: In the short term, I think the governments have all kinds of programs that are supposed to ameliorate the supply of water to inhabitants even in rural areas. And I think effort should be geared towards making sure such programs are continued and are sustainable and effective.

I; How long will it take the government to do this?

KI$_1$: I can not answer that question, because it depends on the intensity of work, it depends on the funds made available for such programs. You know that in an area like Nigeria, there are all kinds of competing needs of the people, so government has to set the priority right and act accordingly. I think safe water for drinking is primary, it should be top-most in their priority list, but what the Politian's do is different from what the scientist think, so that's just it.

I: If you now look at water supply in terms of quantity, access and quality, which one do you think have the highest priority, looking at it from government to end-users?

KI$_1$: Water quantity, I've always believed that there is enough water to go round even in a place like Abeokuta here. The problem has always been distribution network. I know that in Ogun State here, the distribution network still in use now was put up between 1976 and 1978 when the State was created and since then, although the town has expanded to almost 3, 4, 5 times in size in the 1970s, water distribution network has not been improved upon. That is the old town and perhaps 2 or 3km from it on all sides that could enjoy safe treated water from government. Over half of the city is new now at least established maybe in the last 10 or 15 years and they can not even enjoy treated water even if there is one available because the distribution network is just not there, so there is a lot of work that has to be done on the part of government in the area of increase in distribution network which will carry water to the people.

The town has been growing at a faster rate than the government has envisaged or government has neglected the issue of extension of distribution network for too long.

The quality of water again is naturally good, both surface water and ground water are of good quality naturally, but the sanitation practice of the people still has to be improved upon may be through public enlightenment programs. We've been having some of them in the past, and I'm sure they must have been having some effects as time goes on.

I: In other words, you can not really prioritise quantity, quality and access to water supply

KI_1: The priority to me is the quantity. As I said, distribution is difficult, but taken globally, there is enough water to take care of the population but the distribution is not even. The distribution can not get to every where, where it is needed without effort by government to ensure distribution to where water is being needed.

I: If I get you right, you are saying that we need the quantity to be right first before talking about the quality of water

KI_1: Quantity and quality are… is it with respect to domestic consumption?

I: Well, yes, to household uses

KI_1: Well the quality is important, but what I've just said implies that water taken at its face value i.e. natural water taken at its face value here in Abeokuta is naturally of good quality. Ok, any pollution that may be detected in it now is due secondarily to influence of the population, unhygienic sanitation practices, and the lack of adequate or ideal disposal method of wastes, all these has been contaminating the natural water and thereby altering its natural status.

I: Then, do you really think there is enough awareness about the quality of water amidst water stakeholders?

KI_1: I think now with time, people are more aware, but a lot still needs to be done in that area. For e.g., I think people know that if they boil their water it will be of better quality than just taken the raw water like that. But again in some area still in the outskirt of Abeokuta, people take water directly from surface sources or from their wells without further treatment. They consume them and surprisingly enough they don't suffer any visible ailment as a result of that. It seems the body mechanism gets used to consumption of such unclean water (if u like), whereas, if a person that is strange to that settlement (a stranger to the village) will go there and take the same water that the villagers has been taken without any consequence, that fellow will immediately fall ill because the chemical impurity there or the biological impurity in the water will have immediate effect on that person; the fellow will fall sick immediately. You must have noticed that too. Whereas the people there will take the water and it won't be of any consequence to them.

I: So, you think there is enough awareness amidst stakeholders

KI_1: Yes, there is, there is. People are aware, but again there are areas that people do not have any choice so they just consume what they have. If there is no choice, there is nothing they can do.

I: If we now limit it to self supplies now, meaning the alternatives that individuals/households come up with for themselves; hand-dug wells, boreholes, privately owned by people, how do you perceive the quality of such self-supply systems?

KI_1: Well, people know that to get adequate water and constant supply of water, the best thing is to be independent of government just like supply of other infrastructure too in Nigeria. The government has failed virtually in all sectors, so people have to supply all infrastructural needs. So any family that can afford construction of hand-dug wells, they easily make that a priority and as soon as they have enough money to under go the construction, they don't hesitate, they go ahead with it. The same thing applies to construction of boreholes, those who can afford it, they make it there number one priority and they make sure that they sink one to satisfy there daily needs. So it's not that people don't know that the best alternative for them is to be self-sufficient, to be independent of government, but their financial status is maybe a limitation to such an attempt.

I: So, if people are going into construction of self-supply systems, they must have a way they think about the quality of those supplies too

KI_1: In a way yes, even those who can not afford boreholes, because borehole water is perhaps the safest source of water from contamination point of view, but even people who can not afford boreholes who have to limit themselves to digging of shallow hand-dug wells, you find some of them taking water samples to the State Water Corporation for chemical determination of such water to establish the levels of fitness for drinking. I've had some people approaching me on what they could do with their borehole water and I've had to ask them to take the samples for analysis. Some enlightened few do that and they do that because they feel the quality may not be right for them.

I: Still on the subject of borehole, now that we are talking about it, can you please share some of your experiences as a borehole drilling expert in town?

KI_1: Well, in Abeokuta here, as I indicated earlier on, the town is underlain by basement complex rocks consisting mainly of ligmatites, granites and gneisses and they are weathered variations. Particularly in the weathered sections, we have water occurring there to a limited extent and the quantity of such water again depends on the thickness of the weathered portion or weathered regolith. We also have water occurring in the floodplains of the numerous streams that are in Abeokuta here, particularly because such floodplains also coincides with areas where you have fractures in the rocks and fractured rocks do contain appreciable quantity of water. Then you do have areas where you have an underlay of alluvium and these standing deposits do contain appreciable quantity of groundwater. In essence, one could say that at depths of perhaps 70 to about 150 feet around Abeokuta here, we do have water, natural water occurring, but the quantity may be just enough to sustain an average family size and I'm thinking of a family size of 6-7 people.

I: What are your experiences in terms of the number of people that can afford borehole and the quality of borehole water?

KI_1: Those that could afford to construct boreholes are definitely less than 5 % of the population because as I've said it depends really on what they can afford. When you have a borehole costing about 500,000 thousand naira, one can imagine that those that can afford to spend that kind of money can not be many in a society like this. That is why most people opt for hand-dug wells which are cheaper but off course which, are limited in depth, because the depth of most hand-dug wells here on the average are about 20 – 25 feet, some are shallower than that, but the deepest are around 20/25 feet before you get to the fresh hard rock which can not be penetrated by hand.

I: So what is the typical depth of boreholes?

KI_1: Typical depths of boreholes are around 70 – 150 feet.

I: Now as a self-supply owner, how do you handle self-supply water quality management from source to point of use?

KI_1: What we do is that we used reinforced 6'' diameter PVC casings in the upper 20/30 feet depth to ensure that contaminated shallow waters do not get into the hole and then we screen, we use DVC screens for deeper depths or where the deeper depths are really within the fresh rocks, we may not need to even screen at all, we just dig into the fresh rocks and we are sure that at that depth, there can be no contaminated water seeping in. But in our construction procedure, we would have taken care of shallow water seepage by ceiling such waters off from the boreholes. Most of our boreholes do not have contamination arising from seepage from shallow waters.

I: So in your own house, how do you manage the quality of your supply, at distribution and so on?

KI_1: I have a 6'' borehole which is about 100 feet and which has been cased at the upper 20 feet and I installed 1 horsepower submersible pump into it and I passed a supply pipe of 1'' diameter into 2 overhead tanks. In that case I have a closed system which is not open to contamination. Water pumps directly from the borehole into overhead tanks and from the tanks into the house, into all the points around the house where I want water from. Water comes directly by gravity from the elevated tanks into the house, so nobody has any access to it, so it can not be contaminated.

I: So, people just get water directly from the tap?

KI_1: Yes.

I: Do you still need to store water for use after the tap?

KI_1: No, we only store water in the overhead tanks. We have two 2000 litre tanks. We store water in the 4000 litre storage tanks that we have and water comes from there thru gravity into the house because the tanks are elevated. Once in a while, twice a year, we wash the tanks because sometimes we have sediments coming from the borehole into the tanks, so we clean up the tanks to remove the sediments and we put them back to get our clean water.

I: How long have you been living in Abeokuta?

KI_1: I have been in Abeokuta for about 22 years now.

I: In that case, what can you tell us about the people or a brief history of the town? 20 years is a long time.

KI_1: I agree 20 years is a long time. When I 1st came in to Abeokuta, you have to travel say about 15 km from what now looks like the outskirt now before you get into the town Abeokuta. What I am saying in essence is that the town within the last 20/25 years must have expanded some 10/15 km in all directions really. Because initially before you have a feeling that you are entering Abeokuta, you must have travelled almost to the middle of the town, but that is not the case any longer. When you are, say 10/15 km to the centre of the town now, you already believe you are in Abeokuta. So that is how fast the town has grown. And I think this is not un-connected with the fact that the town became a State capital in 1976 and I think with time a lot of effort and money pumped into the capital city must have attracted people to settle in Abeokuta. The town has grown a great deal and particularly because we have a lot of tertiary institutions now established either directly in the town or in the neighbourhood.

I: I was surprised to find few wells within the real down-town areas of the town, what do you think could be responsible for this? I'm talking about the core centre like Grammar, Sapon, Igbore, Ake area and so on

KI_1: Well, these are areas that one can easily term the old Abeokuta townships and in such areas in the past, you have good coverage of water supply distribution network from the State Water Corporation. Some of them may have broken down now; part of the network may have broken down. But initially when the town was still so tiny, it was easy for the Water Corporation to cope with water supply. So all these areas actually had water, treated water from the State Water Corporation. With time however, some of the network had broken down, they were not replaced nor repaired, so people then discovered later that they had to dig wells to supplement whatever government is able to give. Today the broken down networks had not been replaced so the people are restricted to the use of their hand-dug wells. That's why you have very few wells in old Abeokuta town.

Also old Abeokuta town developed around rock outcrops. Where you have such hard rock outcrops, you can not dig hand-dug wells since the rocks can not be penetrated by hands. That's the second factor there.

I: In terms of self-supply system's quality monitoring now, who in your own opinion could best do the job amongst the stakeholders – government to the water users?

KI_1: Perhaps because of my exposure, I will say that government have failed otherwise I would have thought that government is the best agent to monitor water quality. But I started my career by working in the Federal Ministry, I knew how we were doing it at that time and I know now that government agencies do not do it any longer because of funding. They are not well funded, equipments are not there. So, if one wants to embark on such monitoring activities now, I would suggest that tertiary institutions could be empowered to do that and if they are empowered in terms of materials and some funding, they probably have more at stake because the student could even have first hand practical knowledge of how these things are done and the interest is there for them to do it. I believe they could be more useful and more reliable than when you expect government to do that.

I: Is it possible to exploit a government-self-supply owner/user collaboration on this?

KI_1: Self-supply? That will be totally private water supplies?

I: Yes

KI_1: Well maybe, I have to modify that by saying perhaps if you get some consultants. Consultants like private companies who have water experts, if they are charged with that they may be in a good position to do it, but they have to be empowered before they can really do that satisfactorily.

I: So are you saying it is not possible to get a government- self-supply owner/user relationship on this issue of water quality monitoring of these private wells?

KI_1: Government-owner relationship or collaboration? I don't see that working because it seems people have lost confidence in government and the government workers are notorious for being corrupt and un-reliable and I don't think that private people will take government seriously enough to want to empower them to do that kind of operation. The confidence is not there.

I: What can you tell us about the climate of Abeokuta especially the rainfall pattern? Because I know this also has its influence on groundwater

KI_1: Yes, it does. Abeokuta is located in southwest Nigeria and it experiences well defined wet season or rainy season and well defined dry season. The dry season starts from around February – March, immediately after the hamattan in January. One can say we have a well defined 3-4 month dry season in Abeokuta here, whereas the rainy season could be sub-divided into 3; we have the on-set period of the rainy season, which is between April and May. In April you could be having 3-4 rainy days in that month then in May, you may start having 10/15 rainy days and then in June you may be having 20 rainy days in a month. The peak of the rainy season is in July and in August you have a short break of about 2 – 3 weeks where there will be no rain and as you approach September, the rains commences again and it goes on till end of October or sometimes till middle November and immediately after that the hamattan sets in around end November, December till January. And then after January maybe by first week February, you are again in the dry season. So if you want to take the hamattan period as a dry period too which one could easily do, then you may be having up to 5 months of dry season.

I: In terms of quantity of rainfall - annual rainfall - what is the average annual in Abeokuta?

KI_1: Yes, average annual rainfall is between 1000 mm – 1,200 mm per year but you have about 70 or 75 % of total rainfall occurring within 2 or 3 months in the year and this gives you immediately a picture of the distribution of surface water by rainfall water. That will be June, July and September. Already in October there is a decrease.

I: What can you tell us about water related diseases in Abeokuta?

KI_1: I can not say much on that, although we have some investigations into that in the past mainly by having a look at the records in hospitals to see which of the diseases are really water related, but one must say that in the last 10 or 15 years the situation has been improving. We have not had an outbreak of diarrhoea or cholera here in Abeokuta for many years, and that to me is an indication that one has been able to keep water related diseases at bay to some extent. The most prevalent ailment here is malaria, not dysentery or cholera but malaria. Well typhoid, sometimes because of the similarity in symptoms, I think people are sometimes confused as to when they suffer from malaria or from typhoid. When you have very intensive malaria attack, the symptoms is similar to that of typhoid and I think since typhoid is also endemic here, even if you do medical test, a blood check up, you will always find both typhoid and malaria parasite in the blood. It does not mean that you have typhoid. Because typhoid is endemic here, the parasite will be there but what people suffer from is malaria. Also sometimes because there is prevalence of fake malaria drugs around even the injections are fake, you find people treating malaria without getting cured for it. And once you treat malaria without it getting cured, people automatically say then that what you have is typhoid. Whereas it may not be so, really there are problems here and there.

I: Is there any government agency involved with community water supply or safe water management that you are aware of?

KI_1: Well there are. There are NGOs like private clubs – Rotary International, Lions clubs and the likes that dig hand-dug wells for people and less frequently boreholes and apart from that you have international organizations like the UNICEF. UNICEF has been doing a lot, with respect to sinking of boreholes and so on, and also UNDP, but UNICEF is perhaps the most active of all the international organizations that are looking into water problems and water provision and supply in Abeokuta and environs.

I: What about the government?

KI_1: Supply of water is a constant feature in the program of every government because it is an easy way of siphoning money. Since 1979, provision of water has been featuring prominently in the program of State, Federal and local government. The whole place is dotted all around with boreholes but most of them are not functioning because of corrupt government agencies and officials who could not effectively supervise the contractors after they must have gotten money from them. So government is not lacking in programs that are meant for water but they have not been succeeding. Since 1979, I don't know how much has been spent now – 300 billion or so – since 1979 to date, up till this present moment, there are water projects from Federal government, but they are not functioning. And if I want to go to the extreme, I will tell you that even the borehole that is dug in front of the house of the President of this country *(Immediate past president – Olusegun Obasanjo – is from Abeokuta)* functioned only for 2 or 3 weeks and since then it has ceased functioning and the president has not done anything about it. This is a statement of fact; it is there at Ita-eko.

I: Are there no government parastatals/agencies saddled with this responsibility?

KI_1: Federal government for example has been operating through its parastatals, the so-called River Basins; we have about 30 or 33 of them in the country. The relevant River Basin for Abeokuta is Ogun-Osun River Basin Development Authority. Another statement of fact is that the immediate past chairman of Ogun-Osun River Basin also had a borehole right in front of her house there; I think that borehole functioned for maybe 6 or 9 months, it has ceased functioning, nobody had done anything against it. So if you could have such examples all around – the one in front of the president's house, the one in front of the chairman of the parastatal/agency that is responsible for water supply has also failed and nobody is doing anything about them - then you can imagine what has happened to the others that are dotted all around the place that have ceased functioning, nobody is interested.

I: What about in Ogun State Sir?

KI_1: The examples I've given you are in Ogun State. The president's house is at Ita-eko here. The immediate past chairman of Ogun-Osun lives in Adigbe. The borehole in front of her house is not functioning; the borehole in her house off-course is functioning. The president also has one in his house and that one is functioning too. But the borehole just opposite his house that is supposed to serve his neighbours did not function for a month and he couldn't do anything about it.

I: Then do you see any hope in managing water quality from source to point of use?

KI_1: That is why I told you earlier on that in terms of monitoring of water quality, even the quantity too, if institutions (educational) around are empowered to take charge of such things, I think they may be in a better position to perform because their funding would be made dependent on successful campaign of previous operations. So, once that is there, they know that if they have not performed, they will not get further funds for future operations. So they have something at stake. But if you leave it to government, as long as the officials get their salaries at the end of the month and nothing can stop that, their interest is just not there. We've done that in the past and it has failed.

I: So the concept of water safety for self-supply systems, do you really see it being adopted by the government and/or by the water users themselves?

KI_1: The water users themselves are in the best position of taking care of water safety. For e.g. if government contracts out construction of a borehole and you make payment of such borehole dependent on satisfactory attestation from the community the borehole is meant to serve, then the contractor have no choice but to make sure that the borehole functions.

I: Talking about the privately owned systems now, do you think that the concept of water safety of these supplies can be adopted by the owners/users of systems?

KI_1: Yes off-course, I believe so, it can be adopted. They are the primary beneficiary, isn't it?

I: The management of their water quality, do you also think that it's possible at their level?

KI_1: Management of the water quality is also possible at that level just because they are the people benefiting from it; so they have to be interested in the quality and the sustainability of the supply.

I: But it is one thing to be interested in it, there is another thing to actually know how to monitor it, in terms of knowing the water quality status for instance, do you think such can be handled at that level?

KI_1: If for example the government takes the initial move/step of letting people know that the monitoring of the water quality is going to be to their own benefit, and you also let them know that if samples of their water is brought to the laboratory, as long as the proof is there that its not for any gainful profits, that government will do the analysis and keep the records, I think people would oblige, people would go there, yes, they will go there. But I think we need to have credible laboratories around to really do the measurements according to acceptable standards using methods that are comparable internationally, that's very important.

I: In other words, in your earlier suggestions, tertiary institutions could be used in surveillance, as an independent surveillance body?

KI_1: Yes, yes definitely. Definitely that could function well and tertiary institution too could even be charged with going round to collect the samples. The interest would be there for academics to know what is happening around them. The interest would be there. Particularly for such institutions that have academic departments that are in charge of water supply, water quality, water quantity and so on. I think that would work perfectly well.

I: And hoping that the users would want to take up the management of the systems – operations and maintenance point of view

KI_1: I believe so, as long as the cost is not prohibitive.

I: Thank you very much sir, you have been very helpful. Now may we know you sir?

KI_1: I am a trained hydro-geologist; PhD in hydro-chemistry at University of Hamburg, West Germany

Started my career at the Federal Ministry of Water Resources in 1977, left in 1985 to join the academics and since been involved in the teaching of and research into water resources management culminating in acquisition of the professorial chair in Water Resources Management in 1997. I had varied experiences of surface and ground water occurrences, investigations, monitoring all around Nigeria. I started my career in North-eastern part of Nigeria in Maiduguri, which is about 1,600 km away from Abeokuta in 1977 and worked in other parts of Nigeria too; in Niger State, Kwara State, Oyo State and actually left the Federal Ministry when transferred to Mbikadem (east of the country) between 1983 and 1985.

I have been teaching now for over 20 years and involved with research for about the same period of time. I had opportunities to attend international conferences, symposia, and workshops over the years and took active part in the scope and organization i.e. the scientific committee on problems of the environment where we worked on major rivers of the world between 1980 and 1987 when at the University of Hamburg, chaired by Prof. E. T. Daygins, of blessed memory.

I am still in the academics and I run in-part a borehole drilling company which is responsible for contracts on deep well construction in and around Abeokuta.

I am happily married with children

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Feedback interview session:

I: I will like to share my experience at Ijemo

KI_1: Which area in Ijemo? The problem of Ijemo is that the well dept is low.

I: But the human influence; people are many there.

KI_1: Are you sure?

I: Yes, once you entered into the compounds. There is a place I got to in Ijemo. They do not have toilet. They told me they are using ewekiti (bush site or solid waste dumps)!

KI_1: What is that?

I: My first assumption is that it is a name of a hill. There is no single house with toilet. I was shown the toilet in one of the houses until an old woman came out and explained that they erected the structure there as a mock toilet when the sanitary inspectors were coming around asking for the house toilet. I had even measured the distance of the mock toilet to the well. The woman however explained what ewekiti is; Yorubas call it akitan (solid waste dump site). Invariably, there is no toilet located any where from sapon to as far as Ake. What the people use for sanitation is ewekiti (dumping site)!

KI_1: This Ijemo case is bad one cannot really understand it from just a casual look; you could imagine what market place will look like.

I: One landlord even reported to me that people around don't have toilet they've turned their backyard into breeding areas for mosquitoes, and the mini cemetery (grave yards), within the compounds.

The attitude of people is that they prefer to drink tap water and can go to any length for it (tap water). During the dry season however, they have no choice but the well water; even if there is no water in the well, they sit waiting for the well to spring water.

KI_1: What you have just said about bush site toileting almost sent me packing in Adigbe late last year. When I started perceiving this foul smell, I first thought it was from my poultry but then it persisted. I started feeling uncomfortable but one of my friends who are always passing through my place at night said that people have turn my backyard into toilet and it was the smell that is coming in. I now went to the two apartments behind me. The people living there are about a hundred. I told the landlords that if they will not do something about the toilet situation that I will deal with him. He now explained that he has financial problems but promised to correct the situation.

I: I had an un-pleasant experience in Adigbe. Probably because of the election problems; Adigbe people said that their votes were stolen. On sighting us, people thought we are politicians. One woman yelled at us and forbid us from touching her water. All through the episode, I just sat down and hoping that after a while she will cool down. Eventually she did. Instead of talking to her however, I explained who we are and our mission to one of her neighbours who appeared calm enough to talk to. The people are obviously very annoyed with the election process.

KI_1: Yes.

I: After the nitrates result, I now called her and said she must have been taken good care of her well. The comment made her happy and she started to talk “do you see now when I ask people not to bring their own drawer…..’’. She eventually gave me a name; a well police!

KI_1: That’s a good one; a ‘Well Police’!

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Interview session 2008

Date: 14/08/08

I: I was told of the existence of Landlord’s Association and I thought maybe the association could be involved in co-ordinating the WSP for SSS

KI_1: How will the landlords have the time to incorporate such activities? It is an extended function. This may not be an easy thing for them to do.

I; I have been wondering about the possibility especially concerning the implementation of incorporating the association.

KI_1: It is worth it. It is worth given a try. I am only thinking of the implementation. How do you want to implement such a thing? Maybe the awareness should be created first

I: Who should create the awareness?

KI_1: The people. First, one should let them know that the water they are drinking is of bad quality. That could ginger them up. The moment you make them have a feeling that the water they have been taken is not safe, everyone will be interested. The people will not want to get sick because it is very expensive to get sick here; very expensive. That alone may ginger them up, may make the landlords to be active.

I: But the moment you tell them that the water source has a problem, they shift to the next alternative, which is tap water

KI_1: That is if there is an alternative, because invariably there isn’t. It is being said already that the supply of tap water from the Water Corporation is now even worse than it was last year.

I: Why?

KI_1: It is worse because the government is getting to be in a very helpless situation. They do not know what to do. It is not that there is no enough water, there is enough water but the distribution network is very old. They have to renew them and they do not know where to start from. Most of the workers that are experienced enough to do the work are retired and some have been sacked. Rather than try to get them back through contracts, appointments or appoint them as consultants so that they can show them where these networks are, what to do and so on, they are not doing that. The whole system has been faulty right from the beginning. Documentation is poor. For example, there are supposed to be maps showing the distribution networks, but such maps do not exist. This makes maintenance very difficult. And you can not construct new networks because it is astronomical in cost. These are the problems the Water Corporation or the government are faced with.

The Water Corporations have two schemes in Abeokuta. We have the old and the new one scheme. Both schemes have enough water, but the distribution is the problem. In fact this morning, I heard on the radio that the Water Corporation put up an advert that most of the water pipes are leaking and they want the inhabitants who discover leaking pipes to contact Water Corporations. This means that the Water Corporation is helpless. They can not locate where their networks are, they now rely on the inhabitants to inform them. That is the level of helplessness they find themselves, simply because documentation has been poor right from the world go.

I: This is really interesting. Are you aware of the Nigerian drinking water guidelines from SON?

KI_1: I am not aware of this. This must be new

I: Yes, it is. It is a 2007 document

KI_1: But it will not be different from the WHO standards and the likes

I: No, it is not. But my concern is that the scope of the document included privately owned water sources. Also under the section on roles and responsibilities, the Ministry of Health is specified as the one to ……….

KI_1: Which is wrong?

I: Sir, my question is does this body about water safety really exist anywhere?

KI_1: It does not exist. That is my point. Ii will not surprise me if foreign consultants were involved in drawing up the document

I: No or not quite. There is a list of stakeholder groups involving representatives from the Ministry of Health, Water resource…………Well, the document looks very ideal to me, I do not have the feeling of it being real. I was at SON, they claimed that they are the regulator but pointed out that other relevant agencies like NAFDAC (Nigerian Food and Drugs Agency) should be in charge of implementing the standards. NAFDAC claimed to be after the commercial water providers, but I am still trying to track down the Who for SSS……..

KI_1: Looking at this stakeholder list, I can not see the involvement of the Local Government Council. Meanwhile, the LGC are the closest to the people. This is the government agency that is nearest to the people but that is given the least responsibility and off course not mentioned in this document.

I: No, they are not

KI_1: Well, may be because the expertise is lacking at this level of government.

I: Another thing that is lacking is the department for SSS. I am aware of the agency in charge of the community rural water supply, but none for SSS. Meanwhile the overall health impact or effect that may be generated from the usage of SSS is wider than for community wells and even public supplies. Because if no well is safe and we have more than 2000 wells in Abeokuta, if any epidemics breaks out with the usage of SSS, there may be a multiplier effect created

KI_1: I quite agree with you. This is true. Well, I am really confused here. Nigeria is very funny. Now in this document, the Ministry of Health is saddled with the responsibility. In my opinion, they should be at the tail end of safety. How can you make the person who will notice the effect at the ditch responsible for water safety? Somebody at the source (Ministry of Water Res.) should have been made responsible for water safety and not the other way round.

The safety aspect is noticeable at the tail end of the whole operation not at the beginning. You should go to the source to tackle the problem. So, the Ministry of Health should not have been made responsible for water safety but those who are supposed to produce the water in the first instance.

For the individual wells, the awareness should be brought to the people who are about to construct wells so that they know what and how to construct acceptable and optimal wells. But generally, I believe that the issue of infrastructure development should be the responsibility of the Local Government. The only problem that the local government may have is lack of expertise. But that could be built up. Experts could be moved from the States to the local government o monitor certain things. LG are the grass root operators. Many of the problems we are talking about are not relevant to the government reserved areas (GRA). The problems are with the masses; rural and urban. The LG too do not know what they are supposed to do. They have the money (the resources) but do not know what to spend on.

I: I agree with you on that ground. I do not think that they know

KI_1: In order words, there must be a real orientation

I: But who should initiate the orientation?

KI_1: That is the problem.

I: For WSP for SSS to be done, we need to identify the 'who'; an institution, a framework to implement all the safety matters. Who should initiate, who should carry out risk assessments of the wells, who should monitor the quality of the wells……….

KI_1: What we have now with this SON document shows what is presently operational, that the Ministry of Health should do every thing. Meanwhile they are not moving. They say that they do not have enough money to run the programs on ground; you are saddling them with additional responsibilities.

I: But is there a way to use what we have to get what we want on this matter? As it is SON has given the responsibility to the Ministry of Health in partnership with the Ministry of Water Resources. So, where do you think one can start from? I figured even if you start with the Ministry of Water Resources, where or who will you start with, because they all seem to have a set jurisdiction, an edict or mandate of what they are supposed to be doing within the water sector

KI_1: Yes, they do, but I don't know. In short I am at a loss here. In fact the Ministry of Environment is not involved in this document

I: No, they are

KI_1: What about the River basins, are they involved?

I: No, River Basins are not included here

KI_1: You see, where as you can pin down anything that is happening within the water sector to the River Basins, anything. Presently the orientation of the RB has been shifted from agriculture to water supply. The RB is responsible for the executive executing body for the federal government in terms of water supply. The RB is responsible for water at least they should be doing that and should be involved in things like this.

I: Sorry to cut you in, do we have separate Ministry of Water resources now or is it still lumped with Ministry of Agriculture?

KI_1: I think presently, the Ministry of Water resources is with the Ministry of Agriculture; we have the Ministry of Agriculture and Water Resources. The Ministry of Water Resources started out as a department under the Ministry of Agriculture then became an autonomous Ministry but now it is together with agriculture. The Ministry of Agriculture and Water Resources is responsible for the RB. So the RB reports to them. The RB is responsible for the development of water resources as against agriculture. Although it used to be the two (water and agriculture), but since the past 4 to 5 years, they have been focusing only on the development of water resources.

I: Is that good or bad?

KI_1: It is neither here nor there! Because if they have been able to perform the former perfectly well, then you can say remove that and replace with this but none of it is well developed. Otherwise, if they have been doing very well, we will not be here discussing this topic.

I: I want to pursue the matter of the public health department to know if they still exist and if they do, to see if they can take on the SSS

KI_1: Public Health Department, yes they are with the LG but they are not effective. They used to be very effective in those days, especially in Lagos, but nowadays, they are not effective. However the State Government has realised that the PH department should come back on-stream, but I do not think that there is enabling tools to work with.

I: Many water users claimed that they will comply with PH workers' directives on water safety even though the SSS are not provided for by the government

KI_1: Well, people will comply with government directives. That is if the government sends the PH workers, the people will comply

I think the best approach is for you to propose a series of identified options based on your knowledge of the country. Argue through within each option, for and against, and narrow down on one, which will be your recommendation. Then you will have to justify the recommendation because you can only postulates. This is because infrastructures in the country have broken down completely. Indicate the option that fits any existing one for you.

But my own idea is that the LG officials should be involved even though they are handicapped and that could be solved through training. You can train them and get them involved. You can have long term, medium and short term training; even of 3 – 6 months training. Since the LG is there; but the LG may not co-operate with the Ministries.

I: I do not see any co-operation between the levels of governments on water supply provision. Often you see each tier of government having separate water projects within same location or community.

KI_1: The state government and the Ministries have a lot on their hands for them to start dealing with the grass root problems. Then off course as I said earlier, the Landlords Association should be involved.

The Landlords Association at inception have a single term of reference – security of life and property. But in tackling that, they have become so organised now that one can pin more responsibility on them, since they are the ultimate stakeholders. May be there role could be extended through awareness. Making them to know that they are in the best position to do it and I'm sure they would do it.

I: But who should create that awareness?

KI_1: Who created the awareness for safety of life and property? It just came. It was spontaneous because they realised the problem was there and people were loosing lives and properties. So it was automatic. But in this case, the awareness could be induced. The LG is the nearest to them. The State government and no government official will not be able to or be ready to involve the Landlords directly. Involving the landlords may mean admitting to failure in water provision. But the LG should be able to get them on-board

I: So who will do it? Who should create the awareness?

KI_1: The government will not want to do it and the money is with them. If you say the landlords should create the awareness, where would they get the funds from because they will need some funds? Although since it is the issue of co-ordination……….

I: But they are the owners of these systems and the question is who should initiate the process because SON has already set the guidelines, how do they expect the guidelines to be carried out at that level?

KI_1: I really do not know. I don't even know when SON got themselves involved in these things. I know that FEPA (Federal environmental protection agency) prepared guidelines sometimes back

I: Yes, that process was mentioned in the document and the reasons why the FEPA guidelines was not widely accepted

KI_1: The information given in the SON document about the FEPA guidelines is not correct. SON only said that to justify their involvement in setting the new water guidelines or their interference in water issues. How many people know about the SON guidelines in Nigeria? So that information given about the FEPA guidelines is not correct

I: The SON document acknowledge the existence of the FEPA document, but claimed it does not have wide acceptance

KI_1: But they do not attempt to circulate it in the first instance. Is it only drinking water standards?

I: Yes, it is only for drinking water.

KI_1: Now, how will this regulation tapes down to the state government talk less of the LG. I do not know how many state governments will have a copy of this document among them as at now. Coupled with the fact that the RB is not included, the LG is not included

I: As it is the Ministry of Water resources do not have the department for SSS and yet regulation expects them to comply

KI_1: The problem of the commercial water providers is that the only chemical they use, which is hypochlorite, has many poor qualities being imported. To short circuit this problem now in Abeokuta, many commercial water providers acquire properties close to the Water Corporation Headquarters. You must have noticed the many chalets along and very close to the Water Corporation. The commercial water providers now tap water directly from the mains of the Water Corporation. The Water Corporation knows about this. They have a fixed amount they charge and collect from the water providers monthly for these tapping activities.

I: What is NAFDAC (Nigeria regulatory body on food and drugs) doing about this development?

KI_1: NAFDAC do not seem to be doing anything. No agency sees anything wrong in the water tapping activities. But that is the water that should be supplied to the people for domestic consumption. Those water factories are not there 2 to 3 years ago. So, I guess, NAFDAC may not bother them. I don't know why such is allowed but that is what is currently happening now in Abeokuta.

I: Ok sir, thank you very much. I will like to test one of my models with you………

KI_1: Yes, there are borehole construction requirements but government do not construct hand dug wells. So, I'm sure that it is only boreholes that they have control over and off course there are specifications for boreholes, but I don't think there is any for hand dug wells

I: Therefore by extension, construction specifications could be developed for hand dug wells

KI_1: I think so

I: Can such specifications be enforced?

KI_1: I think so, if the people know that the PH workers will close up their well.

I: What benefit will having well specifications have?

KI_1: If you line your well, cover it and bail it with a pump, it should improve the water quality

I: Who should do it?

KI_1: The LG should do it because they are nearest to the people

I: But do they have the expertise?

KI_1: That is not a problem. It is feasible. Train them within 3 – 6 months and they will be able to function in that role and effective.

I: Who will train them? See the University of Agriculture, Abeokuta (UNAAB) for instance, they only have the regular undergraduate and post graduate courses. There are no short courses for people in this category

KI_1: the training institutions. The existing institutions could do the training. For instance The Institute of Water resources in Kaduna offer short trainings but cater for only the people in the northern part of the country. The kind of training we need should be located close to the people otherwise training should be carried to the people.

I: Who will provide certification for such trainings?

KI_1: University (Institutions) Senate permission could be sort for such short courses

I: What will be your contribution?

KI_1: My contribution will be to develop the training and get training materials ready

Let me digress a little. The plotting of depth of wells versus TCC and nitrates may also suggest specifications for well construction, but again the geology may be a problem. Once you hit a rock, you can not proceed with digging and may not have the funds for mechanised digging.

I: What about hygiene issues?

KI_1: Tropical environment favours growth of germs. So any household hygiene will be effective. But if you insist, where is the water? We have been talking about water in-availability. So you can only persuade the people, not enforce. Again, who wants to go into houses to check what people are doing?

I think that the Ministry of Environment should have Public health department. I can help you find out. (OGEPA does have PH department but ministry of health do not)

I: Would the enforcement of pump installation be feasible?

KI_1: Pump installation at that level is difficult because of funds

I: What do you think about introducing minimum age limit for well operators?

KI_1: Minimum age limit is desirable but difficult to enforce. You can only use the help available to you for water bailing

Individual landlords can enforce operation rules, not the government

Monitoring can be done by the PH department. But monitoring of water quality; who bears the cost? But a lot can be done at the LG level. Training and exposure for LG heads is also important.

KI 2

Sex:	Male
Occupation:	Water engineer
Education:	Higher
Organization:	Ogun State Rural Water and Sanitation Agency (RUWATSAN)
Date of interview:	08/05/2007

Justification for selection:
KI2 is the Head of Water Supply section of the Ogun State RUWATSAN. The objective of the interview is to locate the agency within the government framework that is directly responsible for the management of self supply systems, if any. And to find out the activities of such agency as relates to water quality management and safe water delivery.

Interviews:

I: Let us start by getting to know you. Who are you sir and who are you to Ogun State Rural Water and Sanitation

KI_2: I am the Head of Water Supply, Ogun State Rural Water and Sanitation Agency

I: When was the agency established?

KI_2: November 2003

I: What is the mandate of the agency?

KI_2: It is a State government agency in collaboration with UNICEF to provide water for people particularly those in the rural areas. Ogun State is one of the guinea worm endemic states in Nigeria and there are two local governments that are actually involved. That was why the UNICEF collaborated with the state government to provide water for the rural people in the endemic places. The two local governments that are actually involved are Odeda and Obafemi Owode local government areas.

I: What can you tell us about water supply in the state?

KI_2: We have not gone to the definition yet! If we talk about the urban Abeokuta, the water scheme at Iberekodo is presently under utilized because the design of the scheme is to take water to as far as Obada-Oko, Ajebo, Odeda, and Kajola, but they have been unable to fully utilize it.

I: Why is it so?

KI_2: It is because of finances. You need more buster stations to be in place, the NEPA (electricity) problem, and the population is increasing day in day out. As far as the rural areas are concerned, we cannot say that we have achieved anything. Now take for example when this agency came in, the proposal was for each Ward to have 5 boreholes; we have not gone to the half of that. We have about 235 wards in the state and if you multiply the figure by five it will be over one thousand and we have not gotten to 250. This means we have not got to where we should be.

I: What is your view of water quality especially ground water quality?

KI_2: In Ogun state as a whole we have three geologic formations, basically the basement complex, the sedimentary formation and the transitional zone. For Ogun state we can say that our ground water is okay. We do not have pollution like in Lagos state. The only thing that is normally found in water here is iron content and since the quantity in there is not much you can as well apply chemical to treat it. But the surface water is the one that needs treatment.

I: What about the biological quality?

KI_2: The treatment will take care of that. You know that we have a Department of Quality Control in the Water Corporation; they are in charge of those things. By the time the water gets to the end users however, there are a lot of bust pipes because some of the pipes may have been rusted and that's why the users complain about the colour of the water. At times we don't normally have problem with surface water quality

I: What about ground water biological quality?

KI_2: We carry out analysis on most of the boreholes we drilled to determine the chemical-biological ratios. We have the records here. Where they are below standards, we have to treat or introduce a particular chemical. We do such but mostly we don't have cause to treat our ground water

I: But is there possibility of ground water contamination?
KI_2: The only area we have possible contaminations is our deep wells (dug wells).
If it is the local one meant for public utility, people use anything to draw water from those wells; that's why we advice them to cover the wells. We don't have the records of either borehole provided by the state government or the local government and Water Corporation. You know that Ogun State Water Corporation is in charge of urban and semi urban areas, while we have this agency in charge of rural water supply and Ogun-Osun River Basin Development Authority too is for ground water supply. I will advice you that when you leave here you can as well go to the Water Corporation for more assistance in the information that you need.
I: Thank you but before we leave the discussion on general water supply I want to know what is it that you prioritize in water supply: is it water quantity, access or water quality?
KI_2: The priority is quantity; we need quantity and we need access. For example in Ogun state here and in Osun too, they have their drainage basin. They do not depend on Ogun state Water Corporation to give them water, they use their drainage basin. There is this Oyan dam, after releasing water to Ogun State Water Corporation to treat, the dam also release to Lagos state.
I: So in your opinion government prioritized quantity?
KI_2: Yes, look at it this way, if we cannot satisfy ourselves we cannot release for others
I: In terms of awareness, is there enough awareness about water?
KI_2: No, but the government is trying. You need to know that the water issue is a thing that government will be doing is own and the individual will be doing his own. For instance I have my own borehole at home because Ogun state water distribution pipe network has not reached my area
I: Which area is that?
KI_2: Eleweran, very close to the Police head quarters. In terms of quality, we in Abeokuta are blessed by God. It is only in some areas where we have transitional zone; by that I mean the areas between sedimentary and basement complex formations whereby the yield is low. It is only in the sedimentary area that you will have water. In Abeokuta if you dig your borehole you will have a low yield, unlike sedimentary formation.
I: So there is awareness?
KI_2: Yes there is awareness
I: You said drilling in Abeokuta may not yield much water because of the formation, unlike other places where you have sedimentary formation. But are people aware of such places where you can get water?
KI_2: Yes, at times in Abeokuta we do use devices.
I: Like what?
KI_2: Like low level indicator
I: Sir looking at what we call self supply systems; I've already explained that they are shallow wells and bore holes owned by individuals.
KI_2: Some of the people the literate will understand but for the illiterate, you will need to educate them in the sense that they need to know something which they might not know because they are laymen.
I: Know what?
KI_2: For example if you go to local people some of them may have hang ups where you tell them that you might not have sufficient water like in the raining season but they will get good water when the water level rises. We educate them on what will be happening. The only thing that will create problem for the motorized borehole is when the water ……

I: A part of the research work is to carry out inventory of self supply system particularly shallows wells because I realize that we have more shallows well than borehole. And by my estimation so far we have close to two thousand and we are yet to cover the whole of Abeokuta. So we have huge numbers of shallows wells in Abeokuta.
KI_2: It is because of the cost of borehole; borehole is capital intensive.
I: I want to ask you sir, what is government position on water sources like shallow wells since we now realize that many people depend on this type of water.

KI$_2$: The reason is that the water government is supplying cannot reach everybody that is why people decide to have their own water. And government cannot give water because the power supply is not regular. For government to want to pump through generator it is a big money.

I: My question is what is the position of the government on the usage of self supply systems and the quality of such water?

KI$_2$: The government has a regulator to take inventory to regulate how people will be digging here and there but because government herself cannot provide for the people that's why the individuals are digging wells.

I: What is the perception of the government about the quality of the self supply?

R: The problem is that government does not have records of these wells. For example, I have my own in my compound and nobody knows. There are no data for that. It's only what government provides that they have record for.

I: So you are saying that it is not possible to get government opinion on the quality of self supply.

R: The quality depends on the people. I have the record for my in my house. Right now I have low water level and as far as quality is concerned, we don't have problem. But in terms of quality, even at times people will have deep well and still rely on public water. Although government wants to reach everybody but because of this electricity problem; for instance there is no light (electricity) since Friday. So it is only those who are supplied through gravity that has water but not so with the pump based supply line.

I: How do you maintain the self supply you have at home?

KI$_2$: I have the one in my house covered and carry out all analysis and I know that I can drink it and use it for anything. The only thing is that I know that I have traces of iron in it.

I: How did you treat that?

KI$_2$: I have people, friends at Water Corporation who comes and introduced chemical for me. I laid pipe from the borehole to my reservoir from there to my supply. And at times too, I carry out cleaning of the reservoir

I: Do you have separate treatment unit?

KI$_2$: No, I don't need it

I: And you are okay with that?

KI$_2$: Yes

I: Sir, you spoke about the monitoring of the public self supply, who in your opinion should be responsible? Is it the owner (bearing in mind that you said it is what the government supplied that they have record of) or the government or any other agency?

KI$_2$: It should be the responsibility of the government. They cannot ask people to do it unless they coordinate, have data; the government can do it if they want to do it.

I: So you think it should be the government rather than the owner?

KI$_2$: Yes and they (the owner) would pay a token amount

I: So one can expect a possible collaboration between the owners, users and the government.

KI$_2$: Yes

I: And you think such collaboration is visible

KI$_2$: Yes

I: How do you see the climate of Abeokuta in relation to water supply?

KI$_2$: The climate of Abeokuta is hot because of the terrain. We have the two peculiar seasons here.

I: Do you have any idea on water related diseases in the city?

KI$_2$: The one that is common in Ogun State is guinea worm, diarrhoea and cholera. Government is fighting to eradicate them. And I've told you about the activities of the UNICEF and other NGOs

I: You also mentioned other government agencies involved in water supply

KI$_2$: I told you about the Water Supply and Sanitation Agency, Ogun-Osun River Basin Development Authority, it will help you, you need or you should go there.

I: I want to believe that government is aware that their effort in water supply has not gone round and they should also be aware that people have alternatives where there is no public supply.

KI$_2$: Only if they can afford it; but they go to stream or turn to pure water

I: If I may ask you do you see any hope of managing water from source to point of use?

KI$_2$: Yes, if only government wants to do it. Individuals do it, but only that water is capital intensive *(political will)*

I: Do you see the concept of water safety plans being adopted by the government?

KI_2: Yes, if you see any counsellor now one of his priorities is water. They will say we will provide water for you; it's all about water, water. No politician will say that water is not important. For example in Lagos you can dig loam and get water and if you go deeper you get the water quality that you need. The government knows where the problem is they know that water is very important.

I: If water is important to the government as you said, don't you think that the quality of such water should have been paramount?

KI_2: Government is doing their best; you know that the population in the urban city in Abeokuta for example the population is growing daily. When you decide a figure for 20 years you re-appraise. What has gone wrong is to improve on this? For example they want to do a water project, by the time they draw the bills you know water project is capital intensive and if you don't have water there is nothing you can do. You cannot blame them. Water is not the only thing they promised to give, they will consider other things like road, health, education, they will consider other infrastructural facilities as well

I: Thank you very much sir. I appreciate the audience you gave. One more thing sir is it possible to have a look at the water quality records of the boreholes sunk by the agency?

KI_2: Do you mean everything we did here?

I: Yes, if possible sir.

KI_2: All these are done at the Water Corporation. Ministry of environment did the quality itself. You can as well take the samples to Water Corporation, they will do it. They have a standard laboratory.

I: How many of these can I have, just to compare them?

KI_2: I am coming.

KI 3

Sex:	Male
Occupation:	Water chemist
Education:	Higher
Organization:	Department of Water Quality Controls, Ogun State Water Corporation
Date of interview:	10/05/2007

Justification for selection:
The author was informed of the existence and the activities of Water Quality Control department of the Ogun State Water Corporation by the Head of Water Supply, Ogun State Rural Water and Sanitation Agency (RUWATSAN). RUWATSAN claimed that urban water supply is the responsibility of the Water Corporation and self supply water quality management should be resident with the department of Water Quality Controls. The interview session is to ascertain the truth claim.

The Key informant is the Chief Chemist of the department of Water Quality Controls. The interview session was secured with the Head of department, who had an urgent matter to attend to hence second the Chief Chemist to take on the interview session on her behalf. The interview session took place in the office of the Head of the department.

Interviews:

I: Sir, what is the name of your agency and what are you into?
KI_3: The name of the agency is **Ogun State Water Corporation**. We are set up by government to produce and supply potable water to the entire citizens of Ogun State.
I: What is really your mandate?
KI_3: We are covering the entire Ogun State.
I: And in your own opinion how far have you gone with your mandate in the state?
KI_3: We would say we have really gone far because in all the local government areas we have one scheme or the other going on. I will not say we have covered everywhere, but you may have heard that even in Nigeria the people who have access to public water is just about 60%
I: To what extent are you into community water supply?
KI_3: I want to get your definition of Community water supply, are you talking about a village or the whole citizenry?
I: You've just told me now that your mandate covers the whole state, if we now put the state in context
KI_3: To a larger extent, but if you are talking about the rural areas we are not into that. We have another agency OGRUWA they are in charge of small areas that we cannot cover, for instance we are in town
I: Which area are you now responsible for?
KI_3: The urban and semi urban areas Abeokuta, Ijebu-Ode, all the bigger towns.
I: In terms of percentage how much of this towns have you reached out to?
KI_3: If I look into the statistics, generally I am sure the major towns we have reached out to them, but I cannot tell you that everyone has water in each town. For instance in Abeokuta it cannot be less than 75%, I am not talking about the new sites.
I: What is responsible for you not reaching out to them?
KI_3: We are expanding, inflow of people day in day out but we are not really providing extension into those areas and that is part of the problem we have. Lack of proper planning, by now we should have laid pipes into all mini townships
I: What is responsible for improper planning?
KI_3: Finance, Public water supply is a real business
I: Let me say that finance is a big thing as you said but what about planning; when the money comes you know what to do
KI_3: Yes, we have such plans there is good design and plans on the ground.
I: If we look at water in terms of water quantity, access and quality, which of these aspects do you prioritize in your agency?

KI$_3$: The issue of prioritizing is something we have to look at from the African context. First let's have the water, secondly let majority of the people have access to it and thirdly what is the quality? But that is wrong. In the developing countries the order is let people have water first, but in our case we look at the quality first because that has to do with safety of the people. So in terms of the quantity and access to people our top priority is quality.

I: What are you doing to ensure quality supply of water if this is your priority?

KI$_3$: We have chemicals; secondly we have qualified personnel that can do necessary analysis both at the level of production and distribution. And we also go out to monitor form point to see if the quality has depreciated by the time it gets to the end users. We also monitor busted pipes in town to avoid contamination.

I: What can you now say about water quality in Abeokuta especially ground water quality?

KI$_3$: In Abeokuta we don't supply people through ground water, but we have people who do day to day examination of ground water in our laboratory.

I: What is the attitude of your agency to water quality?

KI$_3$: It is high; it is encouraging we have new equipment, infrastructure and new personnel

I: Do you think that the end users are aware of the water quality you supply?

KI$_3$: In African, it is let's have the water first, but they are lucky because the water we have been given them has not been causing any health hazard but personally I can say that our people are not aware of the quality of the water we give them.

I: I have information that Ogun state is one of the cholera endemic states in Nigeria.

KI$_3$: I disagree with you. If you say guinea worm, I might agree with you but if you say cholera, it is wrong. May be you will tell us where you get your data from and which area.

I: Obafemi Owode and Odeda

KI$_3$: May be you want to say guinea worm. I am aware that Odeda is about forth or third guinea worm infection area in the country.

I: If they are having guinea worm it means they are still exposed to stream water

KI$_3$: Yes because they are in the rural area and you will remember that I told you earlier that we are not into the rural areas.

I: Have you heard about self supply systems. These are water systems that are owned by individual or household. Generally it includes borehole, shallow wells, rain water harvesting and they are alternative to tap water. If you do sir how do you perceive the quality of these shallow wells?

KI$_3$: It will be difficult to say that the quality is encouraging, the quality is bad. If it is borehole of around 60m it would have reduced physical contaminations and if you talk about deep well some people have deep well that they seal up and they put engine for pumping. Some people however have shallow wells; these ones are open to contamination. To me I can not really say unless you give us data from hospital about sicknesses like typhoid, cholera etc.

I: What are the possible problems you see with this self supply system?

KI$_3$: Except for contamination no other problems. In terms of chemical contamination, it is very low.

I: Do you think this kind of problem can be solved?

KI$_3$: Yes government must ensue that everybody must be accessible to water by 2015 I mean reducing the number of people who don't have access. I will say that the best way is through what government is already doing going into these rural community sinking borehole for them.

I: You said your agency is not adequately taken care of because of finances, is there a time frame by which you think this can be done?

KI$_3$: There is a focus already

I: I know that there is a focus but when you talk about time there is no definite time frame. Like saying that by next year everybody in Abeokuta will have water in the mean time however, people are using water. I think there is a gap before the government gets to where they should get to, what do you think can be done?

KI$_3$: If anyone tells you that this water system supply will start today it means that the person is joking. Apart from funding let me tell you another problem in public water supply system. The local government, state government and federal government they are all into water supply. The question is where is the meeting point? I am not sure that Nigeria herself has a master plan about public water supply, that's why today you see federal government sinking bore hole and tomorrow state government *(in the same community)* there is no master plan. And there was a time a group study was initiated by one Prof. in Ijebu-Ode because the kind of law we had then was not fully implemented and there is no proper co-ordination. Back to what you said, I will not say that the gap is not existing but I will say that most of the problem we are having is from this local areas and don't forget that they are even encouraging community into partnership unlike before where government will sink borehole in a community and leave, after sometime it will be abandoned but now community are participating in the design and implementation. It won't be long now before we bridge the gap.

I: You said you have water agency for the rural areas, but within the city we have identified areas without tap water and people in such locations depend on self supply sources. What is your agency doing about this group? Who is actually looking into these new areas?

KI_3: We are doing that, a lot have been done about awareness and lucky enough this people also are health conscious; some boils their water, some calls for treatment and there are reduced health risk factor there.

I: How do you think the end users, the owners of these self supplies perceive the quality of the water?

KI_3: Some of them, particularly the elite, they call experts to come and test and treat their water

I: Do you think there should be a department that will be looking into the issue of the self supply systems?

KI_3: The local government is doing that they are into the sanitary inspection and all that, I am aware of a case in Sagamu where one well was contaminated by a neighbour's soak away pit, they (the sanitary inspectors) went there, analyze the water and all that. I equally agree on that as well, due to larger number of people that depend on self supply but I know that the ministry of health has that mandate

I: I want to ask you sir do you have a self supply system?

KI_3: I have a deep well but we don't make use of it because tap water is flowing

I: So, you have access to tap water

KI_3: Yes, the deep well is just for washing and bathing; we don't drink it.

I: And because of that you don't bother about the quality of it?

KI_3: No I have the water chemistry, it is okay

I: And the water from tap is quite regular?

KI_3: Yes, at least twice a week

I: Talking about the monitoring of the quality of self supply system, who is in the best position to handle it? Do you think it is your department or the RUWATSAN or the Ministry of Health?

KI_3: It should be a joint or a kind of collaborative effort, but if you are talking about best, it should be the local government; they are closer. My agency is not that close like the local government agency.

I: Should the initiative also come from the local government or a higher government?

KI_3: I am aware that one of the mandates of RUWATSAN is what you have just said, that's why they are supposed to have offices in all the local government offices. They are supposed to do that and I am aware that they hold seminars to train local government personnel on the issue of rural water supply and sanitation. You know that these two (water and sanitation) goes together. I will also encourage you to go to them (RUWATSAN).

I: Yes, I have been to them and they told me about your department. I know of the Water Corporation, but they told me about the quality control department.

KI_3: There is a department that has to do with quality control in RUWATSAN because we posted personnel there. They are part of us here before but they should have gone with a chemist but may be because we don't have enough here. It is not necessary that they come to us here because we deal with the municipal but they deal with bore hole and little well. I think they in collaboration with the local government should be doing that *(looking into self supply water quality)*.

I: So far we have been able to identify that there is no arm of government targeted toward self water supply.

KI_3: You see one of the greatest problems in public water supply is lack of coordination. The local governments are doing what you are talking about, the RUWATSAN and my agency as well but where is the meeting point? That's why it appears to you as if there is no specific organization saddled with that responsibility but I know it is not. But if you say because of lack of coordination there is no effective delivery I will agree with that.

I: So let's say that all the water agencies are supposed to be responsible for self supply water systems.

KI$_3$: The Local government and RUWATSAN should be responsible; they dig hole and well and they monitor.

I: That is the point I want to raise, they monitor the wells that they dig but there are others owned by individuals.

KI$_3$: It is still their responsibility. I am aware of their mandate. That is why I told you that they hold seminars and workshops; if our systems are not functioning very well it is because there are no ideas or the plans are not properly articulated, it is always at the implementation level.

I: If you actually go out and look at these systems, you will not be able to pin point any agency. That's why I am going about to find out what the government is doing about self supply.

KI$_3$: Can you do me a favour? When you go to RUWATSAN, ask them of their edict that set them up. UNICEF is working very closely with them and you know that UNICEF is more interested in all this little things. That is why Obafemi Owode and Odeda has great presence of UNICEF, if they are not effective it is not that they are not asked to do that (supervise self systems), in the olden days the fear of sanitary inspector is the beginning of wisdom!

I: But sanitary inspectors are resident with the Ministry of Health.

KI$_3$: No, they are essentially local government workers

I: I mean they reside more in the Ministry of Health not at the Ministry of Water Resources

KI$_3$: No, at the Local Government level, they are at local government headquarters and are posted to villages too. That's why if you go to RUWATSAN you will see Health Officers: there package is a beautify one, but if they refuse to implement effectively that should not be the problem of the designers. I am aware that they go for workshops at every local government to give them the mandate.

I: I am expecting the collaboration between government, owners of these wells and also the users of the water - self supply systems. The thinking behind that is that it is not the government that provides the water sources (the wells), they (owners) invested in it themselves and as such they have right and a say in what they have. But also because self supply owners are not professionals they may not know what is wrong with their water. From what you have said however, it is the duties of sanitary inspectors, i.e. if they exist, and they have been working. It is the sanitary officer that we should be looking up to now to be more effective. From what you know, do you think the sanitary officers are knowledgeable enough to do the work?

KI$_3$: I have not said that the whole work should fall on the sanitary officers but I am saying that there is an agency that is saddled with the work, the problem we have is that the collaboration seems not to be effective. And may be because of the method, if you don't involve those who are supplying in whatsoever measures your talking will not work and the people will not even cooperate. I dug my well why are you coming to tell me not to use it. But the truth is that the government is saddled with the safety of the people so as it is your property, government also may say don't kill yourself! Let us say that there should be a forum to bring in the people but every one is not organized, even those who sell like Lagos they are not organized.

I will encourage you may be it can be part of your recommendations, don't do project in community without involving them (the people) such project should be country based.

I: What can you tell us about water related diseases in Abeokuta?

KI$_3$: I can not tell you anything about that maybe you should go to Ministry of health to get their statistics in the last 5 years. Even if everybody that is sick is not going to the hospital, more than sixty percent will. Therefore there should be record but it will be unfair to say the water is from government. If you go to a party, bought sachet of water and later have typhoid fever we can't say that it is from the government but you can relate it to the problem of in-accessibility to the public water.

I: Have you heard about water safety plans?

KI$_3$: Yes, I have heard about it. I think it is the government that is talking major about it. They do not want people to have bad water; they want to plan so that majority of the people have potable water. However, the activities and the environment of people taking the water is another thing. Like someone putting his toilet close to the well. I know they have it and it is elaborate, but majority of people do not know about it.

I: What is your agency doing about this (WSP)?

KI_3: We have a department that goes out to collect revenue. They have other functions too; they mobilize and take complaints. We also encourage our clients to come and complain about leakages and bust pipes and through this we can detect earlier the areas that has problem.

I: How fast is your response to public complaints?

KI_3: We are good on that because quality is seen from the end user; consumer satisfaction is what the customers say.

I: Do you see any hope in managing water quality and do you see the awareness becoming entrenched?

KI_3: It is already a culture; it is part of the design

I: And do you see the water safety plans being adopted in Nigeria as a whole?

KI_3: As I said earlier people are looking for water first. The concept will work.

I: It is nice talking to you; I really appreciate the time and the audience you gave me.

Summary:

1. *The official at the State Water quality control department of the Water Corporation insisted that Sanitary Inspectors - The Public Health Department - is responsible for the water safety of self supply systems and they are resident with the Local government and not with the Ministry of Health n or Ministry of Water Resources*
2. *The State Water Corporation is responsible for the production and distribution of municipal water – Urban and semi (peri) urban.*
3. *RUWATSAN, by set-up edict is responsible for rural water*
4. *Self supply systems, where ever they are located are the responsibility of the Department of Public Health!*
5. *The official recognized the lack of co-ordination between water agencies at the three-tier of government, a factor that he claimed is responsible for in-effectiveness. Lack of co-ordination is also responsible for the in-visibility of role and responsibility among the various relevant water agencies.*

KI 4

Sex:	Female
Age;	42 years
Position:	Chief Environmental Health Officer (26 years in service)
Education:	Higher
Organization:	Department of Public Health, Imeko-Afon LGA, Ogun State
Date of interview:	25/08/08

Justification for selection:
The Chief Chemist of the Department of Water Quality Controls insisted that the sanitary inspectors of the Department of Public Health, generally resident at the Local Government levels are responsible for self supply systems' safety monitoring. The interview session with a Chief Inspector at Public Health directorate is to ascertain the truth claims. Secondly, a number of respondents (source owners and users) pointed out that the sanitary inspectors could enforce hand dug wells management rules.

Interviews:

I: What is the role of public health workers; I have never seen any one of them in action?

KI_4: PH workers used to be very effective

I: That line is really very common. I have heard same statement being said to me repeatedly, so what changed?

KI_4: In the past when the level of education is not so high, what the sanitary overseers know is that insect larvae must not be found in a water pot. The people as well are not learned and not so civilised, so for them the fear of sanitary overseers is the beginning of wisdom. Many of them, even though do not know the implication of what the SO are doing, yet they feared them a lot. It is so bad that as soon as they sight any SO, will drop their water or whatever they are doing and run from the SO. In this modern times however, things are different. We (the SO) do more of health education because there is a limit to how you can harass people.

I: How do you conduct such health education?

KI_4: We do house-to-house health education during sanitary inspection visits to detect nuisances and to abate them

I: What do you mean by nuisances?

KI_4: Nuisances are anything that is injurious to public health, anything. For instance, if there is a puddle of water here that can breed mosquitoes, and you know that mosquitoes can transmit malaria, then that is a nuisance. Or in a house where there is no drainage system, that is a nuisance. If there is no toilet, that is a nuisance. There are some nuisances that you can abate summarily i.e. by giving an oral notice. For others you may need to give abatement notice. If the people now fail to comply with the terms of the abatement notice, then you may need to prosecute them.

I: Do you have the jurisdiction to serve abatement notice and to prosecute?

KI_4: Yes we do and we do that on a regular basis

I: There is a drinking water quality guidelines that was released last year (2007) by SON, are you aware of the document?

KI_4: Yes, I am aware. But the problem is that the Ministry of Environment do not have environmental health officers or public health officers. You see, there are so many policies, ok let me cite an instance. If you visit a 'pure water' company as a health officer for inspection, they will tell you that you are not a NAFDAC officer. This is one of the problems we are facing. There was an instance at Imeko-Afon LGA when we were told that we are not NAFDAC officers. Even some public health workers as well do not even know their right. In my unit, I have to educate workers of their jurisdiction and rights.

Again either the health workers or NAFDAC official, how many are we? It was only last year that the governor employed more hands and even at that, we are still only about 200 officers. In the whole of Ogun State, of 20 LG areas, we are about 200, so how do we cope with the pressure of the work? There was a time that we were only 7 in Abeokuta South LGA. Of the 7, five of us are chiefs. For instance, with my position, I am not supposed to go out again for inspection. Once you rise to an administrative position but sometimes because of the situation of things, I do go out with the team. At Imeko-Afon LGA, we about 8 officers on level 7, none on levels 8, 9 and 10. Officers prefer to stay in the urban areas. The remaining 5 of us are chief inspectors and head of units and departments. We have administrative work on a daily basis, so we do not go out, but we have to.

Even the newly employed level 7 officers; we do not have the middle ranks officers of 8, 9, and 10 to train them. Just two weeks ago, students were sent to us for training. I have to go into my archives looking for materials and papers to deliver because I don't really trust the in-experienced officers. They can not handle them.

I: So you are saying that you have a major problem of man power

KI_4: Yes, we do

I: Again is there a clear or distinct work or line of duty between the public health workers and NAFDAC officials? Do NAFDAC see you as a threat or rival or vice-versa?

KI_4: NAFDAC believed that they (the government) have given them the law and are empowered to handle water. NAFDAC collects water samples of these water companies (commercial 'pure water' and bottled water companies). And you see there is a way they do these things. Our people are very corny. The companies will ensure that the first sample that NAFDAC collect is good water. Subsequently you will see sediments in water that is produced for consumption after NAFDAC approval. In order words, the policy problem is there.

We had a workshop some few weeks back and we use to write communiqués but where do such communiqués ends up? In this particular workshop, I was emphasised the need for the communiqué to see the light. The public health problem is a multi-sectoral problem and there should be a multi-sector approach to it. No single body can handle it. There should be a link between all the sectors. The health officers knows what to do, the NAFDAC as well knows what is expected of them. This was the message at the workshop.

I: I remembered that I asked my interviewee at SON that after the guidelines what next? I was informed that SON is not in the position to implement, that there are some sectors responsible for implementation of the guidelines. I asked them to give me a name and NAFDAC was mentioned. To me however, NAFDAC is a recent development

KI_4: You need to see the rickety vehicles that NAFDAC officers use for their duties. With that type of tools, where can they get to? So let the government call us together to specify roles of individual agencies. Let them also create awareness for the people such that they will know which agency collects water samples and which on does the water quality monitoring. As it is however, no one can stop me from getting to any company or factory for inspection.

I: Well, that is another of my worry; it seems like all the water sectors are eager to get into commercial water providers. What happens to the individual water sources, the household sources?

KI_4: Yes, it is only during inspection that you can look into household water. But I have talked about the manpower problems. How many houses do few officers wants to enter. In Abeokuta South, handling public complaints alone without going out for inspection is enough work. I was recently transferred from Abeokuta South LG to Imeko-Afon LGA in October 2007. Handling public complaints alone is enough work.

I: What are the types of complaints?

KI_4: For example, some digging a toilet near your window, people come to complain. Another example is building a commercial business shop to bar a resident's window. Complaints like that. No toilets and throwing of faecal matters to create a nuisance

I: So from what you are saying the PH officers are active?

KI_4: yes, we are busy but not many. That is the problem. The health law book states there should be one officer to a thousand houses (check the figures)

I: I will like to have a look at a copy of the health law book

KI_4: I will get one for you. But with what we have now, about 300 of us to millions of people. You can do the calculations to see that the manpower is grossly inadequate. And the population is increasing. Apart from that, you may not meet people at home when you visit the elite areas during working hours. So what we do often is visit places like the rural areas or where there are illiterates. Chances are that you will meet them at home and usually, these set of people are dirty too.

In elite areas, the problem of overgrown weeds is common. When you serve them abatement notice however, you trigger off the political problems. By the time you get to the office, you may have about 5 letters already waiting for you! Claiming why you have to serve abatement notices on one legislative residence or the other

I: How do you deal with such political problems?

KI_4: It is the grace of God. The issue is that most of them are your employers, so you have to be tactful. There was a time when a colleague of mine went for inspection at Ifo and confiscate exposed bread. After a complaint by the bread sellers to the LG chairman, the chairman asked the officers to return the bread. Claiming that he has been eating such bread long before the officer was born. So we are plagued with such embarrassment from both within and without.

I: Would there ever be a consensus over anything in the country?

KI_4: So far I can say that there is only one particular LG chairman that I have enjoyed working with. This was at Sagamu LGA, indeed I was surprised. Often you will find this chairman after making an arrest call on the public health officers to come and take over. There was an instance when he called on me that he just caught someone dumping refuse in an un-authorised location. He did similar things on at least 3 occasions before I was transferred from the area. So I can say that we enjoyed the co-operation of the LG chairman at Sagamu. In other areas however, even the councillors will embarrass you for doing your job. So you see that this is also another type of problem and you have to handle with care.

Sometimes also you will get to court and even the president of the court before you know it 'things' would have exchanged hands behind you back (implying bribery of even the judges) and judgement will go in favour of the offenders. Really we have a lot of problems.

I: Could you please explain to me the process of your court procedures? Are lawyers involved like in normal court proceedings?

KI_4: We have lawyers that can stand in for offenders as prosecutors. But the enlightened ones do come with their lawyers. Their lawyers could represent them. That is why you have to be careful as PH official. You have to make reasonable presentation of your case because the law is there you can not just write rubbish.

That takes me to another set of problems – the public health laws. Many of the laws are obsolete. So we have to be very careful to prosecute nowadays. In public health laws where the fines are N50.00 naira (£0.2), one shilling (currency before Nigerian independence in 1960) and all ridiculous amounts of money, and you go to court over matters that attract such ridiculous fines. How do you convert pre-colonial currency? Things are a bit better in the rural areas where the people are not so knowledgeable, people will not be probing. Where the people are enlightened like the urban centres, you have to be very careful.

In some cases the LG are allowed to make adoptive by-laws. Sometimes in Yewa north LGA, we have the problem of stray animals. Stray animals (cows, goats) can cause accidents; in fact they cause accidents on roads. So I put up a bill to the House (of assembly within the LG) for adoptive by-law. I ended up spending 7 years in the LGA. Up to date the bill has not seen any light. It was one excuse after the other. Many of those politicians do not even know what to do. Many are not even learned. Some of them are illiterates, some semi-illiterates; these are the people sworn-in, can you imagine? There are so many things that need to be done, many projects, so many initiatives to explore, but the political will is not there! These are the problems, these are our experiences.

Even the issue of refuse collection is the statutory duty of the LG. The State government had to take it over from the LG. If you write proposals to the LG chairman, they are not interested. They prefer to do something else like build class rooms and embark on projects, which they can commission and which the people can easily see that they are doing something. The State government now deducts certain percentage of the LG fund allocation per month for refuse collection. They prefer that, can you imagine?

Can you imagine a LG without rakes and cutlasses and there are people to work. Really if I have the opportunity, I would have resigned because there is no job satisfaction. You know what to do but there is no political will on their part to do anything. (And off course I have my children to think about; they are yet to complete their education, otherwise…..)

I: I think I will agree with you on that point about the lack of political will. Seeing the transformation of Lalubu road to a beautiful London road made me to come to similar conclusion that the problem in this country is not money but lack of political will

KI_4: It is indeed political will. As professionals we know what to do but they are not ready. It is only what the politicians' want that they do……..

I: So the political will is another big problem

KI_4: Yes, it is. Again when they want to formulate or enact all those policies, the relevant stakeholders are never involved. For instance, when they started the household refuse collection, we just heard it on the radio. The PH department was not consulted, we were not involved. And you see, we know how to talk to the people. Are the people ready to pay the refuse collection rates and so on? The public is not ready for this. It is only within the elite that you can get some o-operation. All the others are not ready to pay for refuse. Is it someone who can not afford N200.00 (£0.8) to cook a descent meal that you will ask to pay for refuse collection?

But there is a way to go about doing such things. We can encourage the people. You can ask them to combine households. For instance in the case of asking households to build toilets, we combine households and even partner with them to support their effort, especially in the rural areas. We have meetings regularly with the public.

There was a time that the PH was asked to present a work plan assuring that they (LG council) want us to work together. To our dismay, they just went to submit the plan to the governor without meeting with us. When we sort audience with the governor, we were not allowed to see him

I: So what you are saying in essence is that if the political will is there, we have the professionals to get to the households and get thing done. But my research focus is on SSS and off course sanitary inspection is involved……

KI_4: Sorry let me come in here. I understand your focus but it brings us to another problem. The government has failed to supply water to the people. Now the people have struggled to provide themselves an in-sanitary well. You visit as a health officer, in the first instance, the people sees you as their number one enemy. You need an approach to first calm people down to explain your presence……..

I: I know that feeling……

KI_4: Then you inspect and begin to advice that 'please you will need to make some repairs or work on that area', but you will also wonder at the scenario. The state of most people are so pathetic for the level of poverty that you will think to offer them N500.00 (£2) to help them than asking them to look for funds to repair in-sanitary conditions of wells. Hence, you have to use your discretion. The situation is really bad.

I: But we have to do something

KI_4: Yes, we need to do something. On my part, let us hope that the communiqué we submitted a few weeks back will achieve something. We recommended in the document that public health issues can not be handled by a single agency. All stakeholders have to come together. Let there be a forum where all stakeholders will meet and specific duties will be assigned for each stakeholder.

Government recently awarded a contract to a private company for emission control. The head of the company recruited some un-employed graduates, trained them up for the job and send them out without any prior experience. Meanwhile, emission control is one of my areas of specialization, up to Masters Level. What I am saying is that the government do not need to spend extra in terms of man power to resolve the issue of emission control. The man power resources needed are available within the government work forces. The human resources are there, what we need is material resources. The government do not need to waste resources on further acquisition of human resources. This is also one of my recommendations in the communiqué. But because they want to find food for people who voted or sponsored their electoral ambitions….that is another problem.

I: Let me again narrow the discussion down and back to water. I can reliably tell you that there is no safe well in Abeokuta based on research findings. What can you do about this?

KI_4: I agree with you, there can not be a safe well in Abeokuta. This again is very difficult. There are some instances in Itoku where there are no landed spaces to build toilets and you see several grave sites lined up around the properties. The public have no tap water; they can not afford boreholes, the site of the water they can afford is very pathetic! In any case, we do ask some households to close up their wells if we found that the water is too poor for consumption. But the problem is that they will close up the well for a while till they perceive that the public health workers have shifted attention away from the area. In some cases they tell us that they do not drink from wells or that they will drink pure water. We do advice people on what to do for new wells. Like minimum distance to toilets or locating wells at higher elevation to toilets.

I: But so far I have discovered that there is no specific agency or department for household water supply

KI_4: RUWATSAN should be responsible for that. May be you should visit them but household water is not really there duty

I: No, it is not. I have been to RUWATSAN

KI_4: But they have the support of UNICEF and they have conducted 2 workshops for us here

I: I am aware of that but RUWATSAN is concerned with communal wells and not household wells. My point is that we have over 2000 household wells in Abeokuta alone. The nature of these wells is such that they are owned by one household or individual but many households make use of them. So if we say that none of the wells are safe, then you can imagine the effect or impact on the people. It's like a multiplier effect because the usage is broad based. Thus, if we really want to tackle the problem of water, then the issue of the household water sources should be resolved. So, household wells are more critical than communal or even tap water in our context.

KI_4: Put like that, I agree with you. It is true and you are right; very correct. In that case what we used to do especially in Imeko-Afon LGA where I once served was that we go about to treat individual wells.

I: What type of treatment are you referring to?

KI_4: Normally we use chloride of lime for the treatment of water but the problem is that the people will not even want you to treat their water. Many objected, demanding what you want to put in the wells. We embarked on awareness campaign before the program was successfully implemented.

There really is a problem. Government officials, politicians just sit down in their offices to formulate policies; policies that have no bearing with or on the people. The health workers will go out, interact with the people, they know what is happening. Yet the government will never consult them. Anyway experiences are now forcing the government hands to start to involve at least the people, the end users. A well was once commissioned by a lady commissioner in one of the LGA. Unknown to them, there is a taboo in the community that prevents inhabitants from taking water from any source that a woman takes water from first. After the commissioning off course the water source was abandoned. No one touched the borehole or take water from it. Wasted effort, wasted resources. It later took an insider to understand the problem.

I: That is why research is always very important

KI_4: Yes, the community never saw it as their project. Events like this are gradually forcing the hands of government to involve the people. Now the government are asking the people to highlight the project they want the government to do for them in individual communities. They (the people) take the lead and you (the government) follow. This is especially the UNICEF approach, involving the people from the start. The approach is called the CLTS – Community Lead Total Sanitation.

I: I guess that is exactly why I am here. Many of my respondents pointed me towards the public health workers. They believe that the PH workers are in the best place to enforce some of the rules in the management of SSS

KI_4: That sounds interesting to me because many of these people are also very funny. They may follow the instructions of PH workers for the sake of it but may not use the resource.

I: What do you mean?

KI$_4$: I will again refer to Imeko-Afon LGA. When the sanitation program was embarked on, so many latrines were built but the people will not use them. Property owners erected toilets for the sake of getting the PH workers off their back but they do not use the toilet.

I: Why is that?

KI$_4$: Simply because it is a taboo in that community to scout on holes to defecate! When we visited, we saw that toilets have been built and we were satisfied that the program was successful and the people complied meanwhile the on-site or bush-site sanitation is still very much being practiced. That is another problem.

That is why it is better for the people themselves to identify the problem and proffer the solutions they want by themselves. Otherwise our effort might amount to futile exercise.

I: Alright, I understand your line of argument. In the case of SSS, my research work is centred on developing WSP for these types of sources but there is the problem of who should co-ordinate the exercise. Already there is a lot of problem about the management of the wells. The management problems are a bit simpler when the owner is resident. In most cases however, owners are not resident. You have the resident users claiming lack of control on non-residents and non-residents saying that the resident users do not have the right to bar them from using the wells……..In essence there should be a body or institution, a 'who' to monitor the wells, take samples, monitor the water quality and so on……..Again the users do not realise that the water is not safe, but we know from research that the water is not safe. So who should go out to conduct sanitary inspections, 'who' should do risk assessments, who should test the water, who should monitor the sources…..?

KI$_4$: Well, the 'who' are the PH officers. You have rightfully identified the institution; it should be the PH department………..

I: The people did the identification

KI$_4$: But there is another problem. Do you believe that in the whole of Ogun State, there is no PH laboratory where you can take your water samples to or your food samples? So if you collect any sample now, you have to get to Ibadan (the capital city of a neighbouring State) to get a laboratory.

I: So there is one lab in Ibadan?

KI$_4$: Yes, there is a PH lab in Ibadan

I: I did my sample analysis in NIMR, Lagos

KI$_4$: There is a lab in Ibadan under the supervision of Prof. Shirdar

I: Oh, I know the Prof. His fees were too high

KI$_4$: He was one of my lecturers then at Ibadan. So these are some of the things that will discourage you as a PH officer. To collect samples from Abeokuta and head for Ibadan to get the samples tested!

I: But what you are saying is that within your jurisdiction or mandate, the PH department should be the agency to collect water samples for testing and all that?

KI$_4$: Yes, we are. We used to collect tap water samples too in the past for testing to make sure that they are safe for public consumption, sometimes on weekly basis. That was when you enjoy your work as a PH officer. All the taps, all the water sources then but that was when you do not have so many agencies in charge of water. Today if you try that, they will ask you if you are from NAFDAC. Now we thought NAFDAC is responsible for water and so on. But really, it is our job

I: Not even the landlords?

KI$_4$: No, we should. This case is similar to the veterinary problems in our abattoirs. When I was in training, abattoirs are one of the places we go for training. Learning animal glands, what to look for in animals to prevent public health. The various types of animal diseases like anthrax, etc. Later on however, we were told that abattoirs inspection is that duty of the veterinary medical officers! All political gimmicks!

But it is so unfortunate. They see you as threats, as people who know nothing but the truth is that we (PH department) are underutilised. There are many of my senior colleagues that are so brilliant. You need to hear them speak; we are indeed under-utilised.

We equally once advised that we (PH workers) should be seconded to the Ministry of Health at no extra cost

I: I am even very surprised that PH department is not under the Ministry of Health

KI_4: No, I mean the Ministry of Environment. We are under the Ministry of Environment. The Ministry now stands alone, so are under Environment

I: Is that the case only in Ogun State or generally?

KI_4: Generally. We are Environmental Health Officers. But it doesn't even matter where the department is located. Surprisingly however, even with the Ministry of Environment, there are only two environmental officers and they are not even experienced. Recently they employed some people and called them Special Marshals. The special marshals now go about extorting money from people in the name of monitoring the environment. We complained about the Marshals and the nuisances they are causing and they said that may be they will post the marshals under the PH department. We agreed for the marshals to be posted so that they can do real work

I: In terms of the water treatment, is it the LG that should sponsor it or the landlords?

KI_4: It depends. In rural areas, the people are poor but where the landlords can afford the treatment, they should be advised to do so. We can recommend to landlords to treat their water at least at reasonable intervals. Otherwise the LG can assist and help individual landlords to treat their water.

I: What type of chemicals do you use for water treatment?

KI_4: Chloride of lime and I think potassium permanganate – oh that is for water hardness. I can not remember all of them precisely now. The most common chemical we use is the chloride of lime. We drop this in wells and lock up for 3 days before usage

I: How do you identify the wells you treat?

KI_4: We do this routinely. In the past we collect samples, but since there is no laboratory, we just treat now routinely. Anyway, there is nothing wrong in treating even the water with no problems. At intervals of every 3 months all wells should be treated. Although we are lucky here in Abeokuta that the deep wells are better. It is only the shallow wells that have problems of pollution. So we do advise people to locate wells at a higher level to toilet for example

I: So there are no particular criteria you use to select or identify wells for treatment?

KI_4: No. that is why we treat wells routinely whether we know the wells have problems or not

I: What about the households with existing wells, toilet and grave sites within close distance of each other?

KI_4: We advise the people on the implication of those sources of pollution on the wells. We do ask them to close up the wells because it is the wells that they can close.

I: thank you so much, you have really being very helpful and thrown much light…….

KI_4: It's ok but I want to add that if you know of any NGO, I am really very concerned. If I have the money, I would like to do something, no matter how little, to create public awareness on all these issues. When you see the people, they spend money on what they should not. I really hope that I can help. So if there is any NGO that wants to help and they need assistance, I will not hesitate to render any assistance to them. I will volunteer, even at no cost.

I: I will like to have a look at the PH laws you mentioned earlier.

KI_4: Ok, let me look for it

KI 5

Sex:	Male
Position:	Assistant Public Relations Officer
Education:	Higher
Organization:	Standards Organization of Nigeria (Regulator)
Date of interview:	11/08/08

Justification for selection:
The Standards Organization of Nigeria (SON) in 2007 released the Nigeria Drinking-Water Quality Standards. The author hopes to find out how SON in conjunction with the standards formulation committee hopes to achieve the stipulated standards, compliance and enforcement, especially with self supply systems – the research objects.

Interviews:

I: What is the mandate of SON?

KI_5: The mandate of SON is to ensure safe goods (water, foods, palm oil, etc.) for the populace, with special emphasis on consumable goods. The mandate also extends to non-consumable goods such as electrical, tyres, construction materials and so on.

I: How do you achieve your mandate?

KI_5: One of our main activities is to check for the effectiveness of the goods. And we do this at borders and sea ports. We conduct market raids and we also act on tip offs. All these we do in conjunction with the police force and also work with the NDLEA. Through these activities we can check and control the circulation of sub-standard and un-safe goods.

We also embark on various awareness and educational activities. For example, we produce jingles on televisions and radios. Recently we produced jingles to create awareness on sub-standard vehicle tyres and electrical cables.

I: you mentioned water earlier on, what exactly do you do with water?

KI_5: We ensure that the water made available to the public are safe for consumption; the bottled water and pure water, we ensure that these waters are treated. We visit the water production companies (the government is the sole provider of public water in Nigeria. Water company in this context refers to commercial drinking water packaging companies like bottled and sachet water- popularly referred to as 'pure water') in conjunction with NAFDAC.

I: SON recently released Nigerian Drinking-water Quality Standards

KI_5: Yes

I: How do you intend to ensure compliance to the standards?

KI_5: SON drafts standards. It is the duty of relevant agencies to ensure compliance with the set standards. In the case of water, NAFDAC and NIS (Nigeria Industrial Standards) are supposed to ensure compliance. Any water company must have both NAFDAC and NIS registration before they can operate. SON is also involved in ensuring the quality of any construction.

I: So you are saying that SON set standards. And for water, it is the duty of NAFDAC to see to the implementation or ensure compliance

KI_5: Yes

I: Ok, who do SON reports to? Or who is your sponsor, who pays you?

KI_5: We are sponsored both by the Federal government and private donations. But the Federal government pays our salaries

I: I see.

KI_5: We are trying to get as many private organizations as possible to sponsor our activities and projects because many of our projects are capital intensive. Embarking on education and awareness programs involves a lot of funds for mobilisation and so on

I: How do you get the information that you work on, to know the need for awareness on any matter?

KI_5: We use to organise what we called Stakeholder meetings. We invite members of the public and relevant agencies in particular sectors. For instance, one of such stakeholder meeting was conducted towards the end of last year. Through such meetings, we get feedbacks on varying issues. For example, we once got a feedback on the problem of rope and bucket with private wells. Another was on the un-pure so called 'pure water'. This was actually a menace at some point that we have to tackle through NAFDAC. One of such meetings also spotted the fact that our jingles are limited to the big cities. On that we have decided that all local languages and pictures will be used for subsequent jingles.

I: To me it seems that the activities of NAFDAC is limited to commercial water producers

KI_5: No, NAFDAC is supposed to oversee domestic water as well. They are also aware of the rope and bucket problems with private wells

I: How exactly was that problem tacked?

KI_5: NAFDAC will be in the best position to answer that

I: Ok, going back to the issue of creating awareness, after that what next?

KI_5: Awareness is to enlighten the people. The first step is creating awareness on any issue. This creates enlightenment then education. The third step is enforcement and finally sanction

I: Do SON go all the way?

KI_5: In some case yes, we do. For instance, SON went the whole length in the case of palm oil

I: What about palm oil?

KI_5: We were notified of the circulation of adulterated palm oil; palm oil made through chemical composition and not from palm kernels. We produced jingles to alert the people and to create awareness. We conducted market raids, collect oil samples for testing, confiscate adulterated oils and made arrest

I: You took samples for testing, where?

KI_5: We have standard laboratories where we test the quality of goods; food samples, water, oil and so on. There is one lab on the ground floor

I: That is good to know

KI_5: The main problem however is that people do not want a change. All relevant agencies need to work together to effect positive or desired changes. For instance, the present governor of Lagos State, Fasola, is enforcing transportation rules in Lagos. So if all the relevant agencies declared, insist and determine to make standards work, there is no individual property owner that will stand in the way.

I: I need some clarification or need to understand the points been made under some of the sections in the SON document. Is it possible to go thru the document together?

KI_5: I'm afraid I will have to refer you to our Director. He was part of the committee that came up with the document. Unfortunately he is presently out of town. But you may come back to see him possibly by next week Tuesday or Wednesday because he will be out again for a workshop in the east from Thursday.

I: Oh, ok. I hope I will be able to track him then. Thank you for the audience

KI 6		**KI 7**	
Sex:	Female	Sex:	Female
Position:	Chief Matron (Nurse)	Position:	Chief Matron
Education:	Higher	Education:	Higher

Organization (KI 7): Health Centre, Ago-Oko, Sapon, Abeokuta
Organization (KI 8): Owu Area Health Centre, Owu, Abeokuta

Justification for selection:
Hand dug well owners and users generally claim that diarrhoea, cholera or dysentery are not sicknesses common to the study locations. Some of the key informants also made similar assertions. The author visited two health centres to find out the truth claims. Health centres are generally assumed to be closer or accessible (in terms of costs and sometimes location) to the people than big hospitals.

Interviews:

I: We want to know if there have been any diarrhoea cases and if there are, how many per day?
KI_6: Since I have been here for about 3 to 4 months, I have not recorded any single case. We have had only malaria
I: What about typhoid?
KI_6: Typhoid, No. Personally, I have not recorded any diarrhoea or typhoid
I: And you have been here for about 4 months?
KI_6: Yes
I: What is the name of this place?
KI_6: It is Ago-Oko; it is three communities joined together. This centre has just been opened. It was opened around April, 4 months ago. The centre is owned by Ago-Oko, Ilogbo and Erunbe. The tap water system and this centre were funded by the World Health Organization. So the tap water in these three areas is flowing very well.
I: So you think that these three areas are better than other areas in the city?
KI_6: Yes off course because I treated diarrhoea cases most of the time in other areas where I have worked before now.
I: In Abeokuta here?
KI_6: Yes. It depends on the area, but they are areas without tap water
I: Which areas are you referring to?
KI_6: Places like Sapon, Imo area; I don't think their water is flowing well.
I: What attracted the WHO to this area?
KI_6: Ago-Oko has been previously neglected in terms of this type of project and now we get assistance for water supply, light (electricity), roads, and drainages. The light is good, there is also a school and the three communities are joint owners of this medical centre but so far we have not have cases of diarrhoea here.
I: What is your name?
KI_6: Mrs. Ajibanwo
I: I am Mrs. Oluwasanya
KI_6: This is my colleague she has just been posted here last week, Mrs. Fabiyi
I: Thank you for granting us the audience.

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I: Hello ma. We want to find out if you do have cases of diarrhoea in this medical centre?
KI_7: Yes we do, but the patients normally would have started to treat the sickness before coming to us
I: How do you know that they treat it?
KI_7: By the time they come in for check up the signs or symptoms of diarrhoea like sunken eyes or dehydration and so on are already obvious. Also from the answers they give during diagnosis. We asked them, how long you have been stooling, they may say 3 days. You ask again, what have you used, they will say capsule. The capsule that they meant is tetracycline, but they will

just say capsule. Some may say that they took yellow tablets, which is Flaggyl. So the people do not seek medical help until the sickness becomes critical and getting out of control

I: How many cases have you recorded this month?

KI_7: About 3 cases not more than that. Normally they don't have toilet here. The practices here is to throw excretes near or into streams and you know this is the rainy season

I: So you think it is because they do not have toilet?

KI_7: No they have dirty habit.

I: Okay, you mean hygiene.

KI_7: Yes, hygiene.

I: What about the water, how is the water?

KI_7: They use public tap and tap water runs only when the water is pumped for them. Now is raining season they use rainwater and during this period diarrhoea cases are less

I: Why do you say that?

KI_7: During the raining season instead of keeping the faeces in corners they throw it into water ways for rains to wash them away. In the dry season that is not possible so their waste is kept here and there and that's why diarrhoea cases are many in dry season

I: Do they use well water a lot around here?

KI_7: Well water, no.

I: And you are not sure weather they drink from the few ones around.

KI_7: They are drinking it; they have to because there is no other water for them except well water.

I: But they are saying that they normally do not drink well water that they drink tap water.

KI_7: That happens when they pump tap water for them. They don't always pump tap water for them.

I: So when there is no tap they go back to the well water.

KI_7: Yes, they reversed back to well water

I: And you do not think that the usage of well water may be responsible for diarrhoea, especially during the dry season.

KI_7: The hygiene is the problem; it is their total hygiene

I: Then the diarrhoea cases are they more with the adult or the children?

KI_7: Diarrhoea is more with the adult. You know that they are re-emphasising on breast feeding, so it is more with parents than the children.

I: Is it?

KI_7: Yes

I: How long have you been here ma?

KI_7: Six months

I: So within the six-months, if we count, how many diarrhoea cases have you treated?

KI_7: I will have to go through the records to see the total

I: Is it something that you can do quickly?

KI_7: Well let me try

I: Can you give us a rough estimate like average per month?

KI_7: Something like 5 to 6.

I: Thank you very much. I am Mrs. Oluwasanya

KI_7: I am Mrs. Shorunke, you are welcome.

I: It's nice to meet you

That was a short interview with the Chief Matron of Owu Area of Abeokuta Health Center. She claimed there is an average of 5 to 6 cases of diarrhoea per month; mostly adults. According to her breast feeding of children minimized diarrohea cases in children. She believed hygiene and lack of toilet facilities is responsible for diarrhoea incidence in the neighborhood.

KI 8			**KI 9**		
Sex:	Female		Sex:	Female	
Position:	Traditional Herb seller		Position:	Traditional Herb seller	
Location:	Lafenwa Market		Location:	Itoku Market	

Justification for selection:
Generally, many self supply owners and or users attest to the usage of traditional medicinal herbs for health treatment. Many however declined ever having especially diarrhoea, cholera or dysentery. The author interviewed two herb sellers from two major markets to ascertain the truth claims.

Interviews:

I: What is diarrhoea?
KI_8: Having frequent and watery excretion?
I: Do people frequently ask for diarrhoea medicine?
KI_8: Yes, many people; they are many
I: If they are numbered can you give us a figure?
KI_8: It is how God directs them
I: Ok, yesterday they are like how many?
KI_8: Are they old or children
I: Both young and old, what about the day before yesterday.
KI_8: They are many like 30. You know it is business we even take the medicines to villages
I: But people say that they do not have diarrhoea and that surprises us.
KI_8: Some people use Flagyl (orthodox medicine for stomach upset)
I: Are people really coming i.e. visit herbal stores?
KI_8: Yes, but some not because they have diarrhoea but for sound health (i.e. for preventive herbal treatment)
I: What other common medicine do people come for?
KI_8: Malaria is very common.
I: Do you prescribe for them when they come?
KI_8: Yes, they tell us their problem and if we cannot handle it we refer then to hospital.
I: How many people come for Malaria treatment?
KI_8: Malaria is peculiar to everybody when you have limb joints pain, it is Malaria.
I: What about typhoid?
KI_8: That is worse
I: Do you have people who come for typhoid?
KI_8: Yes
I: Do you know what causes Diarrhoea, Malaria or Typhoid?
KI_8: It is weather that causes it
I: What about Diarrhoea? Is it weather that is responsible for it?
KI_8: No; it is water or eating of something.
I: Ok, thank you very much

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KI_9: I can not talk to you unless you pay me
I: Like how much do you want us to pay?
KI_9: She should bring N2, 000.00
I: She said she is not the one doing the research she was just supervising the process; she said that I own the project and if I can justify the payment (making reference to Dr. Jen Smith, one of the research supervisors).
KI_9: What is your own work?
I: We are trying to examine the safety of the water that people use and how the water affects people's health. People claim that they use herbs when they get sick, we want to know if truly people use herbs.
KI_9: It is our idea, typhoid or dysentery treatment. You will have to pay one thousand naira!
I: Ok

KI$_9$: At least 10 in a day
I: What about dysentery?
KI$_9$: About 10 also
I: Are they old or young?
KI$_9$: The old; it is also common among the children
I: What do you think causes such great trend of dysentery or diarrhoea among the children?
KI$_9$: It is water borne disease and that's why we use Eva water (a popular brand of Table water) to prepare our herbs. Yesterday for instance those who came for dysentery treatment are up to 10. We had about seven children yesterday.
I: Thank you Ma that is all we want to ask you
KI$_9$: An old traditional adage says 'water filth does no kill'! It kills nowadays, for example at our place on Abiola Way there are some water with maggot!'
I: Is it well water?
KI$_9$: No tap water, if such water is fetched into Jerry can, you know that such maggot can not be discovered. You can imagine what will happen if people drink such water.
I: That's why we are surprised when people say that they only have malaria.
KI$_9$: Fever is common.
I: What about typhoid like how many people come for treatment.
KI$_9$: They are many. You can even see those that hawk typhoid herbs around the town. They are really many.
I: Thank you Ma